U.S. Coast Guard Research and Development Center
1082 Shennecossett Road, Groton, CT 06340-6048

Report No. CG-D-02-06

NSMRL SEE/RESCUE® PROJECT TARGET DETECTABILITY TESTING, MODELING, AND ANALYSIS

FINAL REPORT
JANUARY 2006

Prepared for:

U.S. Navy
Naval Submarine Medical Research Laboratory
Naval Submarine Base New London
Groton, CT 06349-5900

N O T I C E

Marc B. Mandler, Ph.D.
Technical Director
United States Coast Guard
Research & Development Center
1082 Shennecossett Road
Groton, CT 06340-6048

Technical Report Documentation Page

1. Report No.	2. Government Accession Number	3. Recipient's Catalog No.
CG-D-02-06		

4. Title and Subtitle	5. Report Date
NSMRL See/Rescue® Project Target Detectability Testing, Modeling, and Analysis	January 2006
	6. Performing Organization Code Project No. 7500
7. Author(s) E. Anderson, H. Greenbaum, T. McClay, and D. Wilson	8. Performing Organization Report No. R&DC 717

9. Performing Organization Name and Address		10. Work Unit No. (TRAIS)
U.S. Coast Guard Research and Development Center 1082 Shennecossett Road Groton, CT 06340-6048	Anteon Corporation 240 Oral School Road Suite 105 Mystic, CT 06355-1208	11. Contract or Grant No. DTCG39-00-D-R00008/ HSCG32-04-J-100059

12. Sponsoring Organization Name and Address	13. Type of Report & Period Covered
U.S. Navy Naval Submarine Medical Research Laboratory Naval Submarine Base New London Groton, CT 06349-5900	Final Report 14. Sponsoring Agency Code

15. Supplementary Notes

The U.S. Coast Guard Research & Development Center's technical point of contact is Mr. Gary Hover 860-441-2818 or Mr. David Larson 860-441-2845, email: Gary.L.Hover@uscg.mil; David.L.Larson@uscg.mil

16. Abstract (MAXIMUM 200 WORDS)

The Coast Guard (CG) Research and Development Center (RDC), funded by the Naval Submarine Medical Research Laboratory (NSMRL), evaluated the detectability of the See/Rescue® (S-R) streamer distress signal device in scenarios relevant to Navy search and rescue operations using data collected during two sea test exercises with the following technical objectives.

1. Determine lateral range curve (LRC) functions and sweep width (W) values for the visual acumen of Naval P-3 aircrews searching without visual aids (i.e., eyes only) during the day. The crews searched for persons in the water (PIWs) with an S-R streamer, submarine escape and immersion equipment (SEIE) life rafts with an S-R streamer, and SEIE rafts without the S-R streamer.
2. Determine cumulative detection probability (CDP) curves for two search periods/methods: during the day with no visual aids and at night wearing night vision goggles. The search objects were PIWs and SEIE rafts with S-R streamers and SEIE rafts without the S-R streamer.
3. Perform a statistical comparison of the detectability of the PIW and SEIE search objects when equipped with vs. without an S-R streamer.

Data collected from the two sea tests were analyzed, and the findings of these analyses are presented.

17. Key Words	18. Distribution Statement
Probability of detection, H-53, lateral range, P-3, SEIE, search and rescue, See/Rescue® streamer, sweep width	DISTRIBUTION UNLIMITED: Document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161.

19. Security Class (This Report)	20. Security Class (This Page)	21. No of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	60	

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ACKNOWLEDGEMENTS

Naval Air Station (NAS) Patuxent River (PAX) hosted the See/Rescue® field tests. Force Aircraft Test Squadron (Force Warfare) 20 (VX-20) and Helicopter Test and Evaluation Squadron 21 (HX-21) provided flight crews and aircraft to act as search and rescue units (SRUs) during the field tests. The support and enthusiasm of the officers and crews is greatly appreciated.

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EXECUTIVE SUMMARY

The Naval Submarine Medical Research Laboratory (NSMRL) See/Rescue® Streamer Project seeks to investigate the value of the See/Rescue® (S-R) streamer as an enhancement to visual detectability of objects on the ocean. The S-R streamer is 25-feet long and 6-inches wide. It is made of international orange plastic and is designed to float on the ocean surface after it is deployed by the user. This report documents research conducted by the U.S. Coast Guard (USCG) Research and Development Center (RDC) to quantify the search performance of Navy aircrews when responding to at-sea emergencies involving submarine escape and immersion equipment (SEIE) life rafts (some equipped with S-R streamers) and person(s) in the water (PIW) using the streamer. This effort is one of three that NSMRL is sponsoring in support of this project. The other two efforts are (1) leeway drift tests using the SEIE life rafts and (2) development of electro-optical target models of the SEIE life raft, the S-R streamer, the SEIE life raft with S-R streamer, and the PIW with S-R streamer.

The USCG RDC was selected by NSMRL to design, conduct, and analyze three at-sea tests to address the following technical objectives.

- Determine lateral range curve (LRC) functions and sweep width (W) values for the visual acumen of Naval P-3 aircrews searching without visual aids (i.e., eyes only) during the day. The crews searched for PIWs with an S-R streamer, SEIE rafts with an S-R streamer, and SEIE rafts without the S-R streamer.

- Determine cumulative detection probability (CDP) curves to delineate the ability of Naval aircrews searching during the day without visual aids (i.e., eyes only) to identify the PIW and SEIE rafts with the S-R streamer and SEIE rafts without the S-R streamer.

- Determine CDP curves to delineate the ability of H-53 aircrews searching at night with night vision goggles (NVGs) for specified search objects. The search objects are defined as the PIW and SEIE rafts with the S-R streamer and SEIE rafts without the S-R streamer.

- Perform a statistical comparison of the detectability of the PIW and SEIE search objects when equipped with vs. without an S-R streamer. Note: previous field tests conducted by the RDC provide LRC and CDP curves for the PIW search object without an S-R streamer.

Testing was conducted during the fall of 2004 and the spring of 2005 off Ocean City, Maryland. SEIE rafts, some equipped with S-R streamers, and mannequins emulating PIWs with S-R streamers were anchored in a designated search area. Naval-fixed and rotary-wing aircrews from Patuxent River Naval Air Station were tasked with locating these search objects while flying a search pattern over the area.

Analyses of the data collected during the field tests produced the following findings.

1. S-R streamer **does not** appear to improve detection probability for SEIE rafts during area searches by fixed-wing aircraft flying at 200 kts.

2. S-R streamer **does** appear to improve detection probability for PIWs during area searches by fixed-wing aircraft flying at 200 kts.

3. Altitude, wave height, visibility, and wind speed are identified as search variables impacting detections.

4. SEIE rafts with the S-R streamer have a significantly better CDP than without the S-R streamer.

5. S-R streamer on PIWs enhances CDP to a level similar to that of the SEIE rafts without the S-R streamer.

6. CDPs are better for lower altitude searches than for higher altitude searches for all search objects.

7. The S-R streamer did not facilitate search object detection by NVGs in adverse conditions.

8. Detection of distant targets was not influenced by the S-R streamer; it is thought that other factors such as target freeboard, color contrast, and geometric shape influenced distant target detection.

9. The tendency of SEIE rafts to align perpendicular to waves and wind may be very uncomfortable for the person in the raft.

10. The impact of the S-R streamer may be degraded by its "floating" approximately one inch below the surface.

11. Twisting of the S-R streamer may decrease its effectiveness.

12. S-R streamer deployment requires a fully conscious and uninjured survivor.

Based on these findings, the recommendations are to: 1) update NWP 3-50.1 and National SAR Supplement, 2) update Navy Search and Rescue (SAR) Doctrine to emphasize the importance of low altitude when searching for low-observable targets, 3) consider further testing focused on NVG detection of PIWs and SEIE rafts with and without S-R streamer, and 4) Navy decision makers should weigh the SAR mission performance improvements provided by the S-R streamer against improvements that could be provided by alternative distress signaling equipment.

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

%	Percent
®	Registered trademark
ALT	Altitude
CDP	Cumulative detection probability
CG	Coast Guard
CGADD	U.S. Coast Guard Addendum to the National SAR Supplement
CPA	Closest point of approach
CT	Connecticut
DE	Delaware
Det	Detection
e.g.	*exempli gratia* (For example)
etc.	*et cetera* (And so forth)
ft	Feet
GFI	Government-furnished information
GMT	Greenwich Mean Time
GPS	Global positioning system
Hs	Wave height
HX-21	Helicopter Test and Evaluation Squadron 21
i.e.	*id est* (That is)
IR	Infrared
ISAR	Inverse synthetic aperture radar
kts	Knots
LR	Lateral range
LRC	Lateral range curve
MD	Maryland
MLE	Maximum likelihood estimator
NAS	Naval Air Station
NAVAID	Navigational aid
NJ	New Jersey
nmi	Nautical mile
No.	Number
NSMRL	Naval Submarine Medical Research Laboratory
NVG	Night vision goggle
NWP	Naval Warfare Publication
PAX	Patuxent River, Maryland
Pd	Probability of detection
PFD	Personal flotation device
Ph.D.	*Philosophiae Doctor* (Doctor of Philosophy)
PIW	Person(s) in the water
p-value	Probability value
RDC	Research and Development Center
SAR	Search and rescue

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS (Cont'd)

SEIE	Submarine escape and immersion equipment
S-R	See/Rescue® streamer distress signal device
SRU	Search and rescue unit
Std Dev	Standard deviation
TAWS	Target acquisition weapons software
U.S.	United States
UDI	Universal document identifier
USCG	United States Coast Guard
V	Visibility
VA	Virginia
vs.	Versus
VX-20	Force Aircraft Test Squadron (Force Warfare) 20
W	Sweep width
WS	Wind speed

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NSMRL See/Rescue® Project
Target Detectability Testing, Modeling, and Analysis

1. Introduction

1.1 Background

The Naval Submarine Medical Research Laboratory (NSMRL) See/Rescue® Streamer Project is investigating the value of the See/Rescue® (S-R) streamer as an enhancement to visual detectability of submarine escape and immersion equipment (SEIE) life rafts and persons in the water (PIW) on the ocean. The S-R streamer is 25 feet long and 6 inches wide. It is made of international orange plastic and is designed to float on the ocean surface after it is deployed by the user. The U.S. Coast Guard (USCG) Research and Development Center (RDC) was selected by NSMRL to design, conduct, and analyze two at-sea tests to quantify the search performance of Navy aircrews when responding to at-sea emergencies involving SEIE life rafts (some equipped with S-R streamers) and PIWs using the streamer. This effort is one of three that NSMRL is sponsoring in support of this project. The other two efforts are (1) leeway drift tests using the SEIE life rafts and (2) development of electro-optical target models of the SEIE life raft, the S-R streamer, the SEIE life raft with S-R streamer, and the PIW with S-R streamer. The leeway drift tests will support development of inputs to models that forecast the movement of SEIE rafts while adrift in the ocean. The electro-optical target models will enable analysts to predict detection of the SEIE raft (with and without streamer attached) and PIW (with streamer attached) for various infrared and night vision sensors in diverse environments using Target Acquisition Weapons Software (TAWS). Appendix A provides a detailed description of the S-R streamer and SEIE life rafts.

1.2 Objectives

Testing to address the search object detectability objectives of this project was conducted during the fall of 2004 and the spring of 2005 off of Ocean City, Maryland. SEIE rafts, some equipped with S-R streamers, and mannequins emulating PIWs with S-R streamers were anchored in a designated search area. Naval fixed and rotary wing aircrews from Patuxent River (PAX) Naval Air Station (NAS) were tasked with locating these search objects while flying search patterns over the area. Data collected from these tests were used to address the following technical objectives.

1. For Naval P-3 aircrews searching during the day without visual aids (i.e., eyes only), determine lateral range curve (LRC) functions and sweep widths (W) for both the PIW and SEIE rafts with S-R streamer deployed and SEIE raft without the S-R streamer deployed.

2. For Naval aircrews searching during the day without visual aids (i.e., eyes only), determine cumulative detection probability (CDP) curves for both the PIW and SEIE rafts with S-R streamer deployed and SEIE raft without the S-R streamer deployed.

3. For Naval H-53 aircrews searching at night with the aid of night vision goggles (NVGs), determine CDP curves for both the PIW and SEIE rafts with S-R streamer deployed and SEIE raft without the S-R streamer deployed.

4. Perform a statistical comparison of the detectability of the PIW and SEIE search objects when equipped with vs. without an S-R streamer. Note: previous field tests conducted by the RDC provide modeled LRCs for the PIW search object without an S-R streamer deployed.

1.3 Measures of Search Performance

This testing used three traditional measures of search performance, lateral range curve (LRC) development, cumulative detection probability (CDP) curve development, and sweep width (W) development, from analysis of the field test data. Sweep width is mathematically derived from and is dependent on LRC development.

Lateral range (LR) (see figure 1) is the perpendicular distance from the search and rescue unit (SRU) track to the target and is also commonly referred to as the range at closest point of approach (CPA). The LRC is derived experimentally by moving a detector through a field of widely spaced and randomly placed targets while the searcher employs parallel straight-line search tracks. Each point on the LRC represents the probability that a target will be detected as it closes from outside maximum detection range and passes by the searcher at a specific CPA range or LR (see figure 2). The area under the LRC corresponding to a particular sensor/target/ environment situation is W (see figure 3). W is the most important measure of search performance when comparing different sensors or sensor platforms searching for a particular target under the same environmental conditions. For parallel track searches, W is used to determine the track spacing.

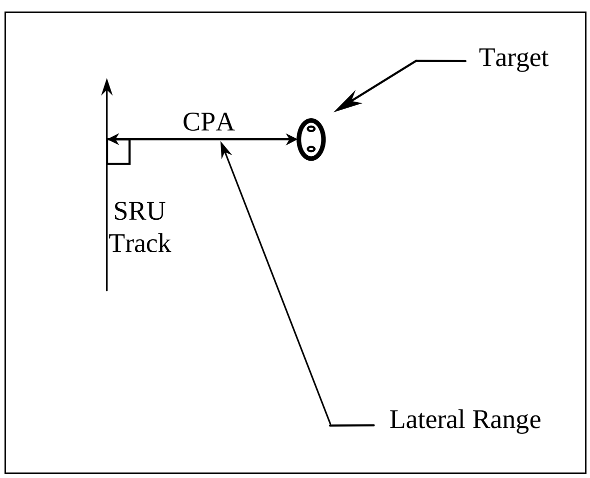


Figure 1. Definition of lateral range.

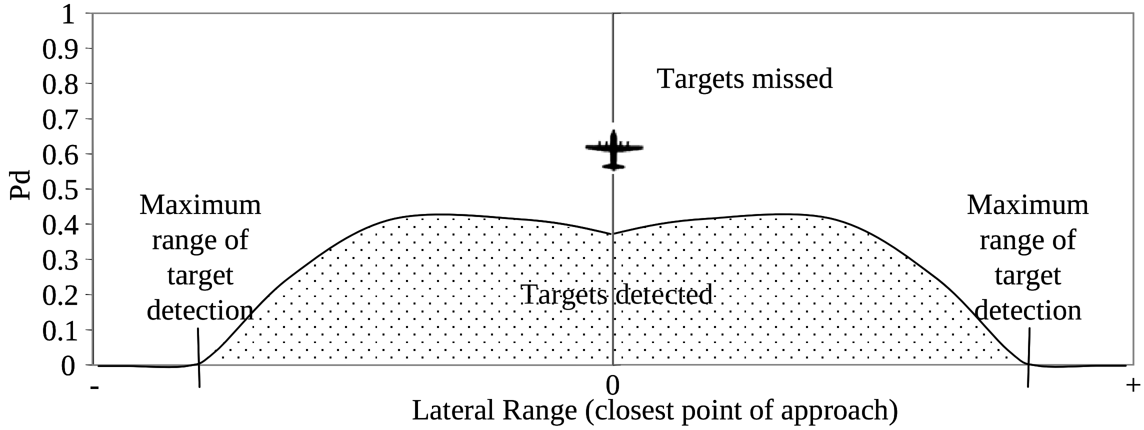


Figure 2. Sample lateral range curve.

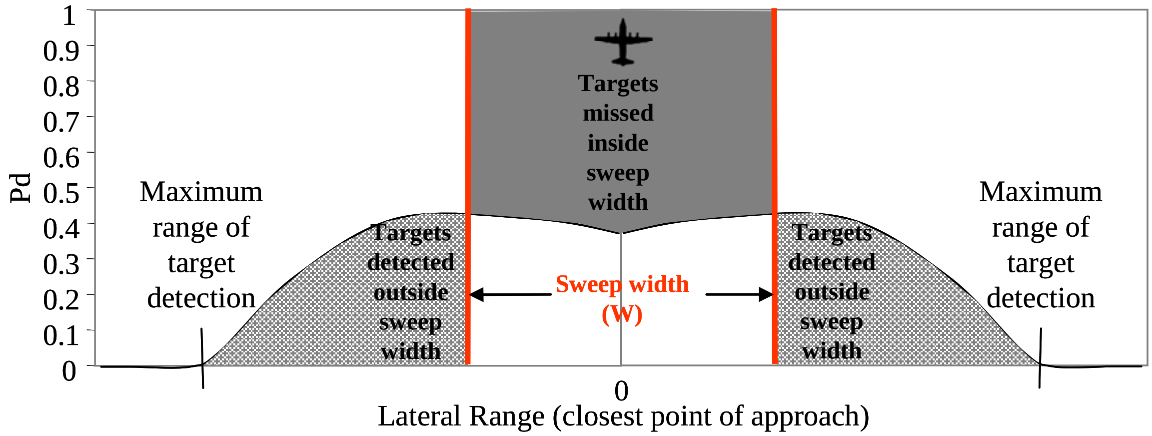


Figure 3. Sweep width diagram.

CDP analysis is conceptually different. The CDP curve (see figure 4) is also derived experimentally but differs primarily in experimental set-up. The experiment involves radial closure of the target to very small CPAs. CDP is the cumulative probability (as a function of radial range) that a target will be detected while closing radially from outside maximum detection range. In theory, radial closing implies a zero bearing rate and a zero CPA. Helicopter CDP testing and associated data collection were conducted to quantify expected survivor acquisition ranges as a function of weather, search altitude, and lighting conditions. P-3 testing was conducted to rapidly determine a preferred range of search altitudes for the small search objects.

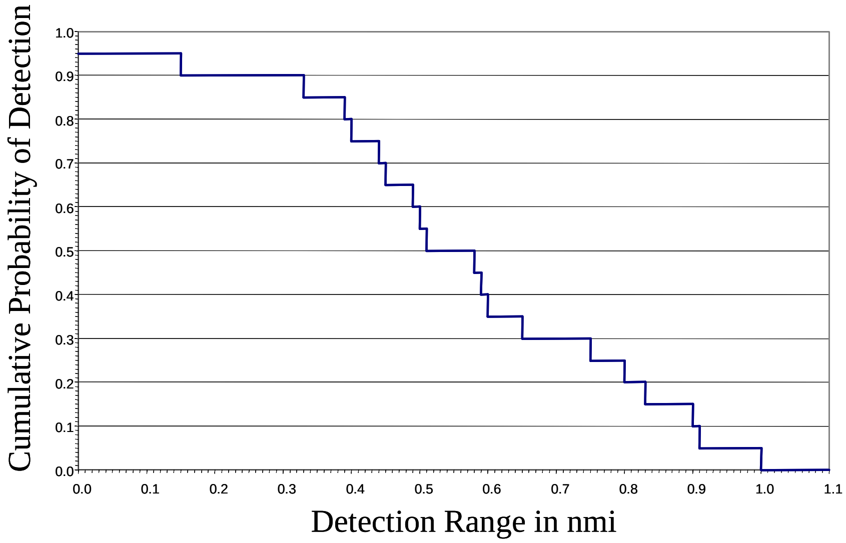


Figure 4. CDP curve.

Development of LRCs requires a large sample set with many detection opportunities. The development of W from an LRC is an integral component of search and rescue theory and practice. Development of CDP requires fewer detection opportunities than the number required for an LRC and replicates the search object location task conducted by recovery platforms after they are cued to a general location by a search platform.

Asset availability and search speeds drove the selection of search performance metrics for each of the Naval aircraft used in the test. The test was allocated 104 hours of maritime patrol aircraft (P-3) fixed wing support and 48 hours of helicopter (H-53) support. Weather, aircraft scheduling issues, and transits to/from the test area reduced these allocations to 64 hours of P-3 and 7 hours of H-53 on-task time, where on-task time is defined as time available for searching the test area. The search speed (200 knots) and on-task time of the P-3 provided opportunities to collect sufficient data to support development of LRCs for the P-3 versus the SEIE raft with streamer, SEIE raft without streamer, and the PIW with streamer. One P-3 sortie was used to collect data to support development of CDP curves for the P-3 versus the SEIE raft with streamer, SEIE raft without streamer, and the PIW with streamer at three distinct altitudes. The search speed (100 knots) and on-task time of the H-53 provided opportunities to collect sufficient data to support development of CDP curves for the H-53 versus the SEIE raft with streamer, SEIE raft without streamer, and the PIW with streamer.

The performance metric selected for each aircraft also supported the likely role that the aircraft would fill during a search and recovery operation. The fixed wing aircraft would conduct the large area search to locate the search object, and search area coverage planning requires an accurate estimate of W. The rotary wing aircraft would then be called to pick up survivors and would fly to the position reported by the fixed wing search platform.

Appendix B contains a more detailed discussion on LRC, W, and CDP. This discussion includes background, theory, and examples of how these metrics were developed for this test.

1.4 Summary of Tasks

Table 1 lists the tasks that were required under the S-R delivery order.

Table 1. See/Rescue® delivery order tasks.

Item	Description	Date Complete	Documentation	Location of Documentation
Pre-test preparation	Verification and documentation of conditions under which PIW and SEIE search objects equipped with S-R streamer device could be anchored within a test area without substantially altering their appearance to airborne searcher.	October 2004	See Rescue Quicklook Report #1 Search Object Validation	Appendix C
Detailed test plan	Details of the performance metrics supported by the data collection, test resource information, roles and responsibilities of all participants, schedules, test procedures, search plans, search object distribution plans, communication plans, safety procedures, test equipment descriptions and operation, data recording media, pre- and post-test checklists, and contingency plans.	October 2004	Naval Submarine Medical Research Laboratory See/Rescue® Streamer Target Detectability Testing	Appendix D
Equipment logistics	All search objects and test equipment were prepared, packed, and shipped to the test site in accordance with the test plan and the search object validation task.	October 2004	--	--
Pre-test briefing materials	Briefing materials for the fall test period were prepared and presented to participating Naval Air Station (NAS) test participants prior to the fall test.	October 2004	See/Rescue® Streamer Target Detectability Testing	Appendix E
Autumn field test	Preliminary documentation of the first test period that ran from 28 October through 7 November 2004.	November 2004	See Rescue Quicklook Report #2 Autumn Field Test	Appendix F

Table 1. See/Rescue® delivery order tasks. (Cont'd)

Item	Description	Date Complete	Documentation	Location of Documentation
Pre-test briefing materials	Briefing materials for the spring test period were prepared and presented to participating NAS test participants prior to the spring test.	April 2005	See/Rescue® Streamer Target Detectability Testing	Appendix G
Spring field test	Comprehensive documentation of the entire See/Rescue® project, including collected data from both test periods and data from the resulting analyses.	October 2005	NSMRL See/Rescue® Project Target Detectability Testing, Modeling, and Analysis	This document

2. Field Tests

2.1 General Description

Three field tests were conducted. The first test, conducted in the early fall of 2004, developed anchoring methodologies that would result in the anchored search objects emulating a free-floating SEIE raft with streamer, SEIE raft without streamer, and the PIW with streamer. The second test was conducted in the fall of 2004, and the third test was conducted in the spring of 2005. The purpose of both the second and third field tests was to collect data to address the technical objectives cited in section 1.2.

2.1.1 Anchoring Methodologies Test

This test was conducted in the summer/early fall of 2004 in Narragansett Bay, Rhode Island, and Rhode Island Sound. The test had two phases. Phase one determined the geometry of:

- A free-floating SEIE raft relative to wind and seas,
- A free-floating SEIE raft with S-R streamer attached relative to wind and seas, and
- A free-floating PIW with S-R streamer attached relative to wind and seas.

Phase two of this test examined the impact of various anchoring methodologies to identify the methodology that resulted in the anchored object emulating an object adrift in the ocean.

The following significant findings were derived from phase one of this test.

- The SEIE raft and PIW search objects appeared to be more influenced by wind than current.
- The free-floating SEIE raft aligns itself perpendicular to wind and seas. Attached to the raft's stern (part of raft where a person's torso resides) is a sea anchor. The sea anchor pulls the stern away from the direction of drift. However, wind forces pushing on the torso area of the raft would, without the sea anchor, result in the stern pointed at the direction of drift. The countering force vectors created by the sea anchor and wind result in the raft aligning itself perpendicular to wind.
- The free-floating SEIE raft and PIW pull the S-R streamer.

Appendix C contains more detail on this test and the anchoring methodology selected for the test. The capstone event for this test was the use of a civilian aircraft to fly over, at 500 feet, free-floating and anchored SEIE rafts with S-R streamers attached. Figure 5 contains pictures taken from this event. These pictures illustrate that the S-R streamer on the raft adrift in the ocean is being pulled while the S-R streamer on the anchored raft is flowing away from the raft. Although the direction of the streamers is 180 degrees different, the impact on visual detection was assessed to be identical.

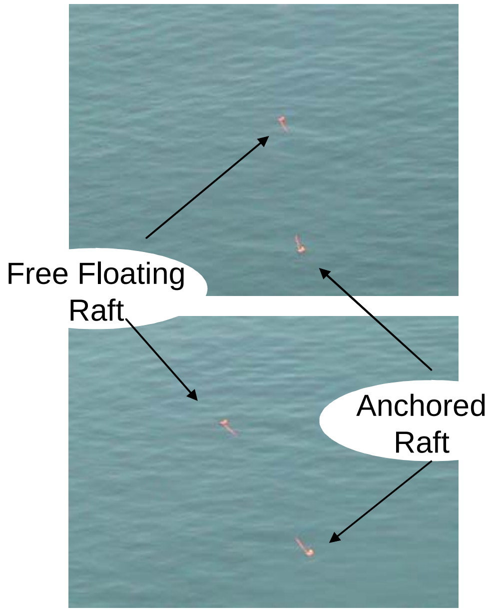


Figure 5. Aerial photographs of free-floating and anchored SEIE raft with S-R streamer attached.

2.1.2 Tests to Collect Data to Address Technical Objectives

Two test periods, one in the fall of 2004 and one in the spring of 2005, were used to collect the data to address the technical objectives. All LRC/W and CDP data were collected during these tests, as described in section 1.3. Data from both test periods were grouped as weather conditions were similar, and post-test statistical analysis showed no significant differences in the data sets.

2.1.2.1 Location

In the fall of 2004 and spring of 2005, tests were conducted in an operations area off the coast of Ocean City, Maryland, and Indian River Inlet, Delaware, as shown in figure 6. This area was selected for several reasons, noted here.

- The water depth in this area is typically less than 100 feet, making the deployment and retrieval of search objects manageable.

- The area is within a half-hour transit from Naval Air Station Patuxent River for fixed wing aircraft and an hour transit for rotary wing aircraft.

- During late fall/early spring, maritime traffic in this area was assessed to be minimal and limited to commercial fishing vessels, tugs with tows, and occasional ocean-going vessels entering and departing the Delaware River.

- Two harbors, one in the north, Indian River, and one in the south, Ocean City, provided excellent staging areas for work boats used to seed the operations area with search objects and collect environmental data.

- Ocean City provided high-rise accommodations from which the test director could achieve line-of-site communications with aircraft and workboats in the operations area.

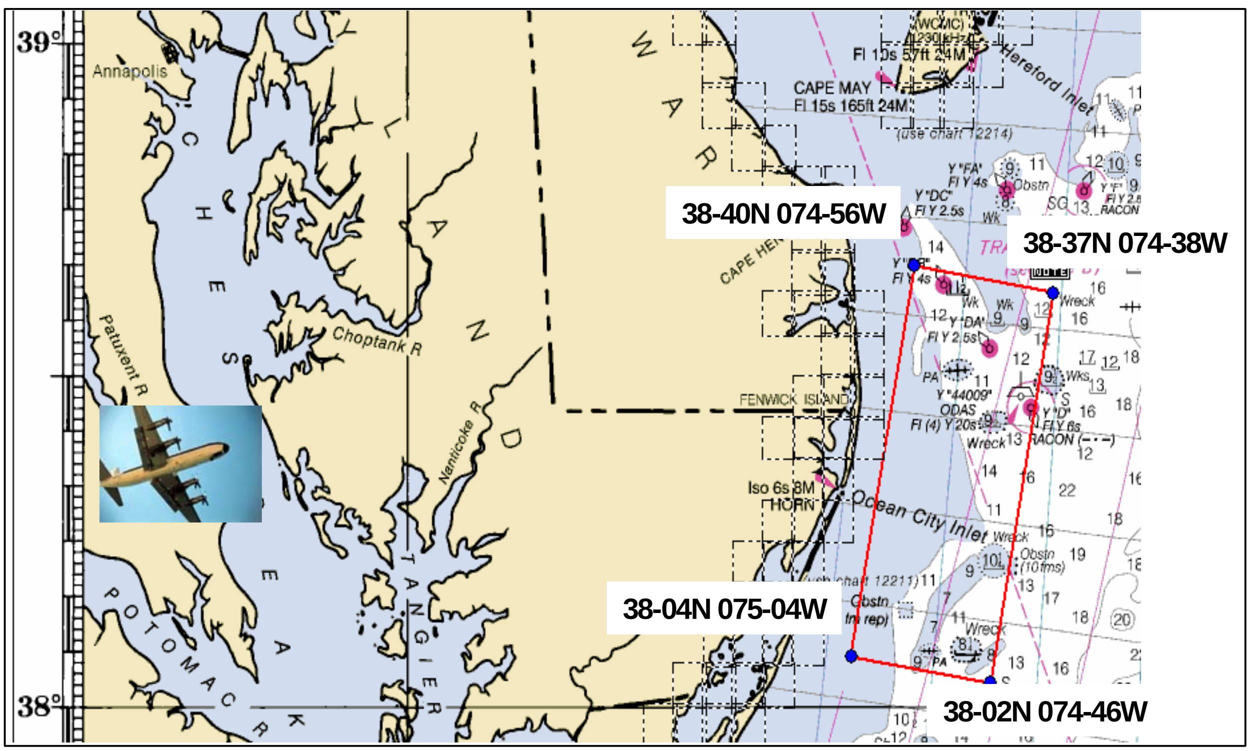


Figure 6. Test location.

2.1.2.2 Test Participants, Platforms, and Sensors

NAS Patuxent River (PAX), Force Aircraft Test Squadron (Force Warfare) 20 (VX-20), Helicopter Test and Evaluation Squadron 21 (HX-21), and Anteon Corporation participated in the field testing. The duties and responsibilities of all test participants are described in the test plan (appendix D).

VX-20 provided a P-3 maritime patrol aircraft (see figure 7) and crew. A total of 104 flight hours were authorized of which 81.3 were used. These assets were used for daylight visual (unaided eye) search in support of LRC development and for one special sortie at three different altitudes in support of CDP curve development. Note: the P-3 was not permitted to use other electronic sensors to aid in their searches (e.g., inverse synthetic aperture radar (ISAR) or thermal/infrared (IR)).

Figure 7. P-3 maritime patrol aircraft.

HX-21 provided an H-53 helicopter (see figure 8) and crew. A total of 48 flight hours were authorized of which 8 were used exclusively for CDP testing. The daylight search (7 search legs) was conducted without the use of visual aids. The nighttime search (4 search legs) was conducted using ANVIS-9 NVGs. Weather and crew/airframe availability prevented full use of the authorized flight hours. Note: the H-53 was not permitted to use other electronic sensors to aid in the searches (e.g., inverse synthetic aperture radar (ISAR) or thermal/infrared (IR) sensors).

Figure 8. H-53 helicopter.

The RDC oversaw all aspects of the field testing, including reviewing and approving the anchoring schema, the fall test plan, the spring test plan, test results, and analyses.

Anteon Corporation provided the test director and observers for workboats and aircraft. Post-test, Anteon processed the collected data for LRC and CDP curve development. For LRC development, Anteon determined the LR of each search object for each search leg and correlated the record of detections with aircraft/search object geographic positions. For CDP curve development, Anteon defined the radial detection range by correlating aircraft position at time of detection with search object location.

Two TowBoatUS franchises, Maryland Coast Towing, Ocean City, MD, and Delmarva Towing & Salvage**,** Indian River Inlet, DE, were contracted to provide workboats. Each franchise provided a workboat and crew. The workboat safe operating limits were established as combined seas of less than 5 feet. Anteon personnel, on board the workboats, directed and assisted in deploying/retrieving search objects in the operations area and recording environmental data during data collection periods.

2.1.2.3 Search Objects

Search objects used during the field test are listed in order of priority.

1. One-person SEIE rafts with an S-R streamer attached (see figure 9). Each S-R streamer is enhanced with six 1-inch strips of retro-reflective tape (three strips per side).

2. One-person SEIE rafts without an S-R streamer.

3. PIW search objects (mannequins) wearing Navy standard personal flotation devices (PFDs) (see figure 10) with an S-R streamer attached. Each S-R streamer is enhanced with six 1-inch strips of retro-reflective tape (three strips per side).

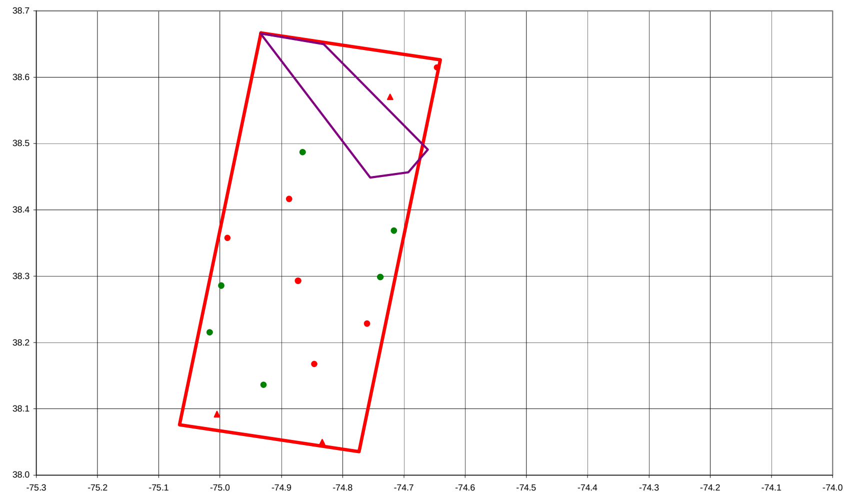
All rafts and mannequins were anchored and ballasted to yield realistic search objects. Detailed descriptions and pictures of each search object are presented in appendix A.

Figure 9. SEIE raft search object with S-R streamer deployed.

Figure 10. PIW search object shown with S-R streamer deployed.

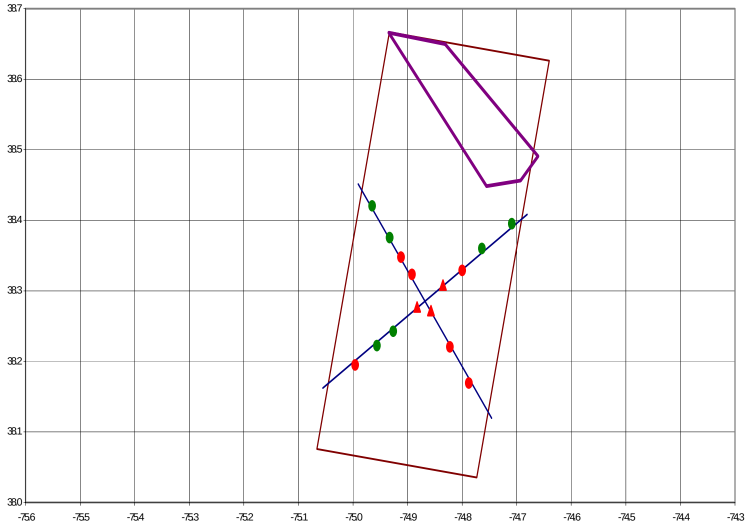
2.1.2.4 *Test Description*

Over both test periods, 14 test days were used to collect data. Each test day supported a single sortie of either the P-3 or H-53. Twelve daytime P-3 sorties were conducted. One day and one night H-53 sortie was executed. Prior to each test period, a detailed test plan was promulgated (appendix D). This plan included 11 test object deployment plans outlining the location (latitude/longitude) and identification (i.e., SEIE raft, SEIE raft with S-R streamer, or PIW with S-R streamer) of each search object. On test days that data were collected in support of LRC development, 15 search objects were deployed in a random pattern throughout the operations area. Figure 11 is an example of a search object deployment plan used to collect data for LRC development. On test days that data were collected in support of CDP curve development, 16 search objects were deployed within 300 yards of two bisecting geographic lines. Figure 12 is an example of a search object deployment plan used to collect data for CDP curve development.



Note: Graphic uses decimal degrees vice the degree-minute notation. Red dot – raft with streamer; green dot – PIW with streamer; red triangle – raft with no streamer. The purple shape in the northern area of the operations area is the vessel traffic corridor for entry/exit to the Delaware River.

Figure 11. Example of search object deployment plan to collect data for LRC development.



Note: Graphic uses decimal degrees vice the degree-minute notation. Red dot – raft with streamer; green dot – PIW with streamer; red triangle – raft with no streamer. The purple shape in the northern area of the operations area is the vessel traffic corridor for entry/exit to the Delaware River.

Figure 12. Example of search object deployment plan to collect data for CDP curve development.

On a typical test day, the workboats, each with one Anteon test observer embarked, would get underway four hours before the aircraft was scheduled to be on station. The boats would seed the operations area with the search objects in accordance with the test object deployment plan for that day. Once the aircraft had checked on station and all test objects had been deployed, one workboat would return to port while the other boat remained in the operations area to record environmental data. The workboats would typically swap midway through the test. Once the aircraft checked off station, the workboats would recover the deployed search objects and validate their locations.

On test days used to collect data in support of LRC development, a Navy P-3 aircraft executed a ladder (parallel) search pattern over the operations area. The P-3 aircrew conducted a visual search for the search object. To avoid crews becoming conditioned to search object location in the operations area, four unique search patterns were executed. The track spacing for each of these plans was approximately 4 nmi. The search plans were constructed such that at the completion of the four search plans, the test operations area was searched with 1-nmi track spacing. Figure 13 is one of the four search plans executed by the P-3 aircraft. Figure 14 depicts the combined search pattern when all four search plans had been executed.

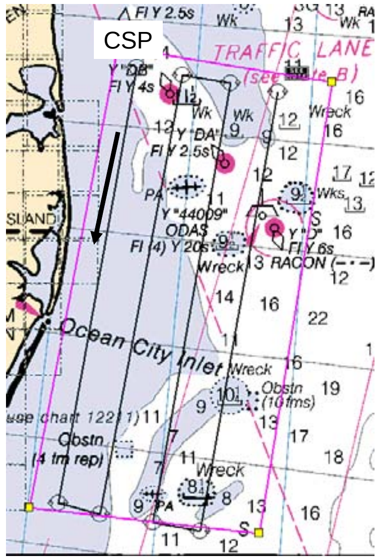


Figure 13. Example of search plan executed during data collection for LRC development.

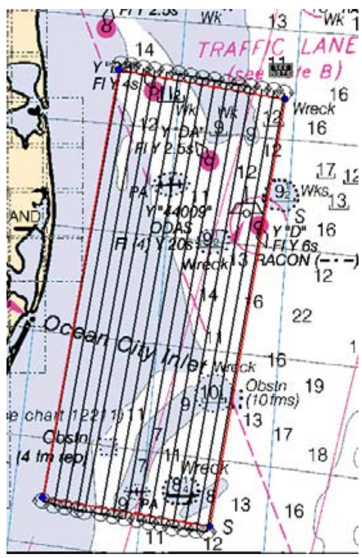


Figure 14. Total aircraft coverage of test operations area upon completion of the four search plans used during data collection for LRC development.

On test days used to collect data in support of CDP curve development, a Naval aircraft (P-3 or H-53) flew the geographic lanes on which the CDP search object deployment plan was based. H-53 and P-3 crews conducted a visual search during the daylight test period. Only the H-53 crew was tasked with a night search using night vision (ANVIS-9) sensors.

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3. Collected Data

During the tests conducted in the fall of 2004 and spring of 2005, data were collected using both manual and automatic recording devices. This chapter provides a brief discussion of the data collection methodologies. Summaries of the collected data are also provided.

3.1 Data Collection Methodologies

When a workboat or search aircraft was in the test area, data were collected to document the exact conditions under which the test was conducted. On the workboats, global positioning system (GPS) data were transferred to handwritten logs to document the exact location of the search objects on deployment and retrieval. Environmental data were also collected by the workboats. An automated GPS was used to document the exact track of the search aircraft. The data collector on board the search aircraft kept a manual record of detections, crew comments, and personal observations from the test. For each test period, the following logs were developed.

- GPS log of search unit track (automatic collection).
- Environmental logs retrieved from the Internet (see appendix H).
  - Ocean City airport data
    http://www.wunderground.com/cgi-bin/findweather/getForecast?query=Ocean+City+Maryland
  - Weather buoy data
    http://www.wunderground.com/MAR/buoy/44009.html
    DELAWARE BAY 26 NM Southeast of Cape May, NJ (44009)
- GPS position log of search object deployment and retrieval location (see appendix I)
- Detection logs – manual record of aircraft crew search object detections, including time, relative bearing, streamer visibility, approximate range, and aircrew position (see appendix I)
- Environmental log recorded on workboats (see appendix I).
- Search crew comments as recorded by onboard data collector
- Anteon data collector comments/observations

3.2 Data Summary

Eleven P-3 sorties were conducted to collect data in support of LRC development. These sorties provided 58 hours of on-task time. Table 2 shows the field test parameters associated with these sorties. Data were combined for the fall and spring test periods because statistics did not show that they differed significantly. Table 3 provides a snapshot of the total opportunities and detections for each search object. An opportunity was defined as a search platform closing to an LR of less than 1.8 nmi from the search object during any search leg. This criterion was based on post-test analysis of detections and is equal to 1.5 times the maximum recorded detection range.

Table 2. Conditions during the P-3 LR testing.

Date	GMT	Altitude (ft)	Sky	Visibility	Wind Speed (knots)	Average Wind Speed (knots)	Wave Height (ft)	Average Wave Height (ft)
1 Nov	1417–2100	500	Clear	10	6.0–10.0	8.8	2.8–3.3	3.2
2 Nov	1340–2013	500	Broken	5	4.0–13.0	9.7	1.7–3.0	2.2
6 Nov	1518–2036	500	Clear	10	6.0–16.0	11.1	2.1–3.8	2.7
7 Nov	1402–1933	500	Clear	10	5.0–10.0	6.9	2.1–2.5	2.4
28 April	1642–2220	700	Clear-Partial Sun	5–10	3.5–9.7	6.4	2.0–3.0	2.3
29 April	1428–1758	700	Overcast	5	4.5–9.7	8.1	1.5–2.2	1.8
4 May	2014–2326	700	Broken-Overcast	7	1.9	1.9	1.9	1.9
9 May	1513–2103	700	Clear	10	3.9–9.7	6.5	3.3–4.5	4.1
11 May	1706–2223	700	Clear	7–8	9.8–15.0	12.0	2.3–2.8	2.6
12 May	1502–2015	700	Overcast	5	5.0–21.0	11.0	0.5–2.0	1.5
13 May	1457–1819	700	Clear	10	11.6–14.5	12.9	2.0–3.3	2.7

Table 3. Summary of data used for LRC development.

Object	Detection Opportunities	Actual Detections
SEIE raft with S-R streamer	241	32
SEIE raft without S-R streamer	269	34
PIW with S-R streamer	328	20

One P-3 sortie was conducted using three different altitudes, 500, 750, and 1000 feet, to collect data for CDP curve development. This sortie was conducted during the spring test to address comments raised by crews that higher altitudes might improve detection performance. Table 4 shows the field test parameters associated with this sortie. Table 5 provides a snapshot of the total opportunities and detections for each search object at each altitude.

Table 4. Conditions during the P-3 CDP testing.

Date	GMT	Altitude (ft)	Sky	Wind Speed (knots)	Average Wind Speed (knots)	Wave Height (ft)	Average Wave Height (ft)
27 April	1623–2109	500 750 1000	Clear	9.7–13.6	10.9	4.9–5.6	5.3

Table 5. Summary of data used for P-3 CDP curve development.

Altitude (ft)	Object	Detection Opportunities	Actual Detections
500	SEIE raft with S-R streamer	27	21
500	SEIE raft without S-R streamer	12	5
500	PIW with S-R streamer	28	12
750	SEIE raft with S-R streamer	45	24
750	SEIE raft without S-R streamer	20	7
750	PIW with S-R streamer	45	15
1000	SEIE raft with S-R streamer	9	4
1000	SEIE raft without S-R streamer	4	0
1000	PIW with S-R streamer	9	2

Poor weather coupled with limited aircrew and airframe availability resulted in only two H-53 sorties, one day and one night, to collect data in support of CDP curve development. Tables 6 and 7 show the field test parameters associated with these daytime and nighttime sorties. Table 8 provides a snapshot of the total opportunities and detections for each search object for each sortie.

Table 6. Conditions during the daytime H-53 CDP testing.

Date	GMT	Altitude (ft)	Sky	Wind Speed (knots)	Average Wind Speed (knots)	Wave Height (ft)	Average Wave Height (ft)
28 Oct	1359–1850	500	Mostly cloudy	7.0–10.0	8.7	5.3–5.9	5.6

Table 7. Conditions during the nighttime H-53 CDP testing.

Date	GMT	Altitude (ft)	Sky	Wind Speed (knots)	Average Wind Speed (knots)	Wave Height (ft)	Average Wave Height (ft)
29 Oct	2304–0030	500	Light Rain	3.0–5.0	4.0	4.6–5.3	4.9

Table 8. Summary of data used for H-53 CDP curve development.

Sortie	Object	Detection Opportunities	Actual Detections
Day	SEIE raft with S-R streamer	27	14
Day	SEIE raft without S-R streamer	18	8
Day	PIW with S-R streamer	18	5
Night	SEIE raft with S-R streamer	24	0
Night	SEIE raft without S-R streamer	12	0
Night	PIW with S-R streamer	24	0

3.3 Search Crew Comments

Comments made by the search crews were compiled from both test periods and are included in appendix J. The consensus was that the S-R streamers made close-in targets easier to see but did not change the range at which they could initially be detected. Detection of distant targets was not influenced by the S-R streamer. It is thought that other factors such as target freeboard, color contrast, and geometric shape influenced distant target detection. The streamers were most visible when looking almost straight down on them, which led the crew to think that flying at higher altitudes might improve detections. The CDP analysis showed that this assumption was not realized.

The sun played a principal role in detections. When the crew was looking into the sun, sun glare made it difficult to see any targets. When the sun was behind the aircraft or overhead, it aided detection capability. At other times, sunlight reduced target color contrast. Lack of sunlight made the targets less conspicuous than when there was bright sunlight.

Fishing buoys, pot markers, and navigational aids (NAVAIDs) with vertical height were easier to detect than the targets with S-R streamers. Heavy whitecaps also made it difficult to detect the streamers. The shape of the P-3 aircraft may cause a decrease in detections. At close range, the crewman has to lean forward into the aircraft bubble and look down to make a detection.

3.4 Anteon Observations

Anteon test participants made the following observations during the test.

- Streamers "float" about 1 inch below the surface. Impact of reflective tape questioned. However, lack of night testing precludes analysis.
- The S-R streamers do not deploy automatically. They must be hand deployed.
- Twists occurred with S-R streamers attached to both PIW and raft search objects (see figure 15). The twists occurred in segments between the streamer stays. The twists did not occur all the time, and the cause of the twisting was not determined. One hypothesis was that the wind may have twisted the streamer when it caught it at the top of a wave. Twisting may be a result of having the targets anchored.
- There is a marked difference in target visibility between glassy seas and light ripples.

Figure 15. SEIE raft with twisted S-R streamer.

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4. Data Analysis

This chapter provides an overview of how the collected data were processed and presents the measures of performance, i.e., probability of detection (Pd) vs. LR, W, and CDP curves, derived from the processed data. In addition, the chapter presents a model developed from the collected data that will enable LRC development for conditions other than those experienced during the field test. These measures of performance and LRCs developed from the model will be used to address the technical objectives of the field test.

4.1 Probability of Detection versus Lateral Range

The Pd vs. LR was computed from data collected during P-3 parallel (ladder) searches of the test area. Derivation of this metric required that the collected data be processed to identify the closest point of approach (CPA) range (i.e., LR) of every detection opportunity for each search object on each search leg. Appendix L contains detailed reconstruction of each search leg. For each search object type (i.e., SEIE raft with streamer, SEIE raft without streamer, and PIW with streamer), detection opportunities were grouped by LR into bins of varying sizes with more bins representing the closer LRs where most detections occurred. Data for the fall and spring test periods were combined because comparison of the binned detection data for each search object showed no statistical difference between test periods. A Pd was computed for each LR bin along with a 90 percent confidence limit on the estimation of the proportion of detections to detection opportunities (refer to tables 9, 10, and 11).

Table 9. Summary of SEIE raft without S-R streamer detections by LR bin.

Bin LR		Bin Weighted Average LR (nmi)	Number of Detections	Detection Opportunities	Observed Bin Pd	90% Pd Confidence
Start	Stop					
0.000	0.175	0.08	6	17	0.35	0.17–0.58
0.175	0.350	0.26	15	38	0.40	0.26–0.54
0.350	0.550	0.45	8	38	0.21	0.11–0.35
0.550	0.800	0.69	4	39	0.10	0.04–0.22
0.800	1.000	0.90	0	30	0.00	0.00–0.10
1.000	1.800	1.47	1	107	0.01	0.00–0.04

Table 10. Summary of SEIE raft with S-R streamer detections by LR bin.

Bin LR		Bin Weighted Average LR (nmi)	Number of Detections	Detection Opportunities	Observed Bin Pd	90% Pd Confidence
Start	Stop					
0.000	0.175	0.09	8	17	0.47	0.26–0.69
0.175	0.350	0.26	13	34	0.38	0.24–0.54
0.350	0.550	0.44	3	23	0.13	0.04–0.30
0.550	0.800	0.69	4	36	0.11	0.04–0.24
0.800	1.000	0.90	2	26	0.08	0.01–0.22
1.000	1.800	1.40	2	105	0.02	0.00–0.06

Table 11. Summary of PIW detections by LR bin.

Bin LR		Bin Weighted Average LR (nmi)	Number of Detections	Detection Opportunities	Observed Bin Pd	90% Pd Confidence
Start	Stop					
0.00	0.07	0.04	3	20	0.15	0.04–0.34
0.07	0.13	0.09	3	10	0.30	0.09–0.61
0.13	0.29	0.21	13	39	0.33	0.21–0.48
0.29	0.43	0.36	1	21	0.05	0.00–0.21
0.43	1.80	1.09	0	238	0.00	0.00–0.01

For each bin, the Pd was plotted (refer to figures 16, 17, and 18) as a discrete point at the opportunity-weighted center LR. The 90 percent confidence error bars provide a reference to evaluate the validity of predictive models of Pd for a specific LR.

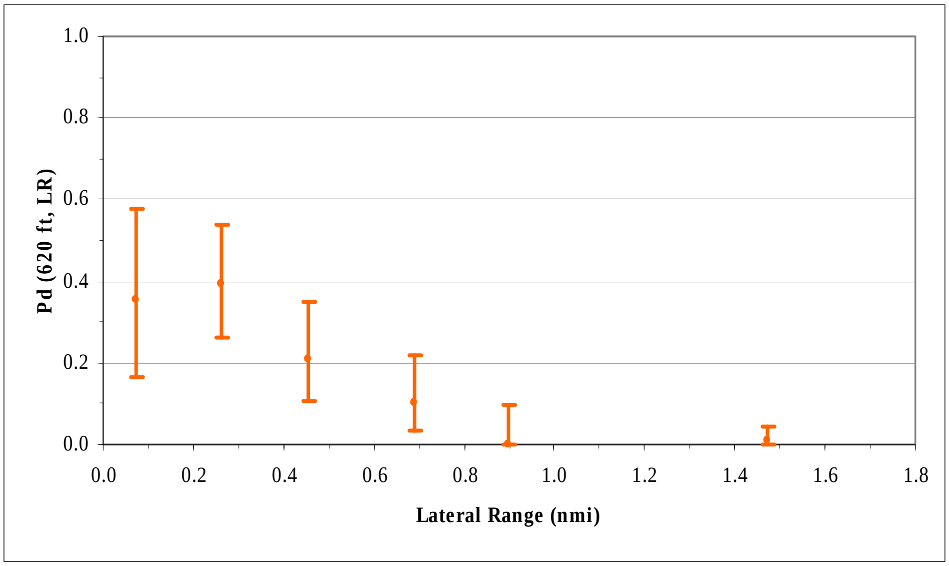

Figure 16. Pd versus LR for SEIE rafts without the S-R streamer (90 percent confidence interval on ratio of detections to opportunities depicted for each LR bin).

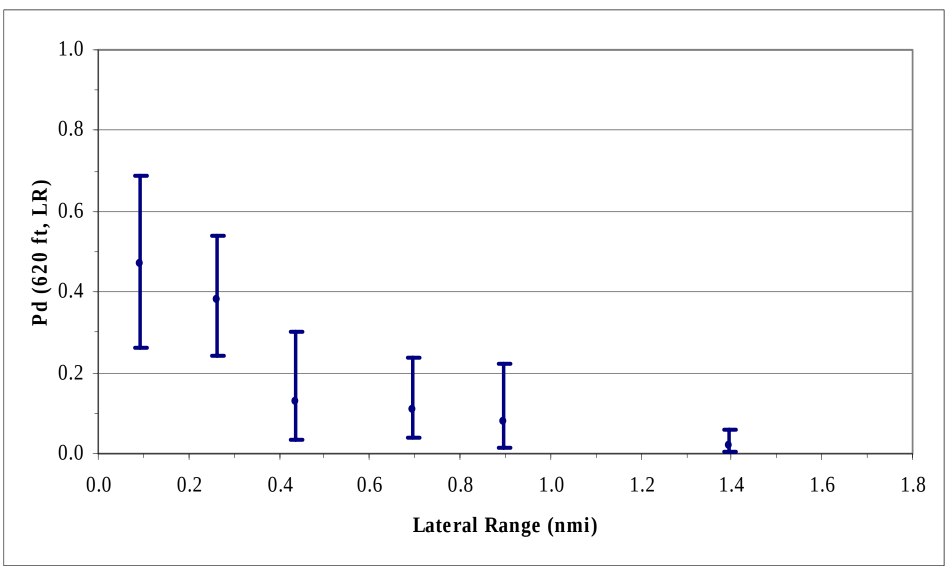

Figure 17. Pd versus LR for SEIE rafts with the S-R streamer (90 percent confidence interval on ratio of detections to opportunities depicted for each LR bin).

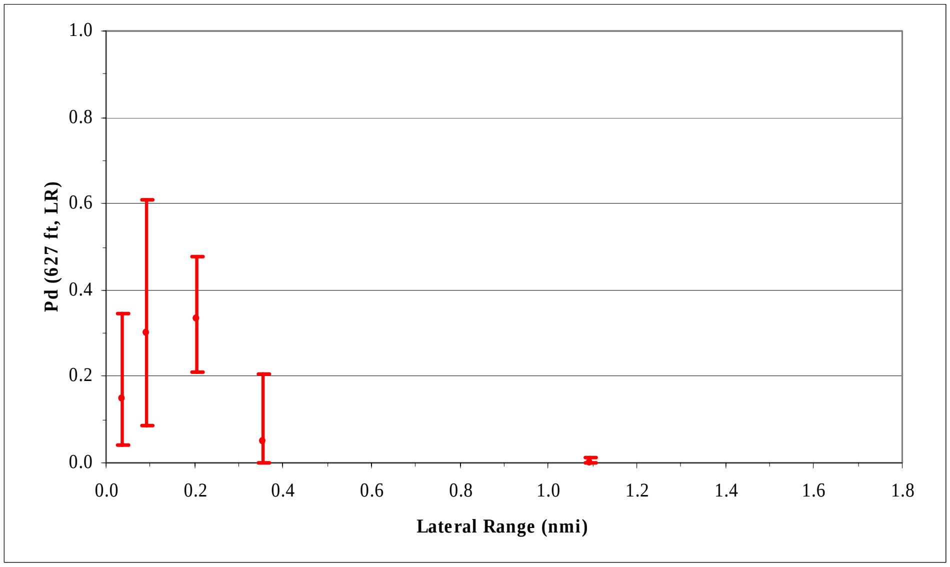

Figure 18. Pd versus LR for PIWs with the S-R streamer (90 percent confidence interval on ratio of detections to opportunities depicted for each LR bin).

4.2 Lateral Range Curve Model from Collected Data

The data were further analyzed to develop LRC models for P-3 aircraft versus the SEIE raft with and without S-R streamer and PIW with S-R streamer. These models can be used to estimate LRCs for SEIE rafts and PIWs over a broader range of conditions than those encountered during the field test. Model validity was assessed by inputting average data from the field test, plotting the resulting LRC, and observing how the modeled LRC fit with the binned data. The model was developed using SYSTAT® Logit multivariate logistic regression analysis (detailed in appendix K).

Relationships between the occurrence/non-occurrence of detection and all possible combinations of independent variables were evaluated using logistic regression to determine which combinations were statistically significant. Because the detection/non-detection variable is binary (i.e., 0 equates to non-detection, 1 equates to detection), the Logit regression model uses a maximum likelihood estimator (MLE) technique to determine regression coefficients. The MLE technique requires using a statistical software application. SYSTAT® was used for this analysis, but applications from other vendors also perform these calculations. The most important output of the statistical software is the value of regression coefficients for variables that are statistically significant and should be included in the regression model.

The statistical analysis software provides several pieces of information that assist the analyst in determining which regression coefficients (independent variables) should be used to predict the value of the dependent variable. In this analysis, the ‘p-value’ output was chosen as the strongest indicator of which variables should be used to predict Pd. It is a measure of confidence in the usefulness of the variable within the regression model. Traditionally, a p-value of 0.05 is used to determine which variables should be included in the model.

For both SEIE rafts and PIWs, predictive equations to estimate Pd as a function of altitude flown (ALT) and LR [Pd(ALT, LR)] were developed using multivariate Logit regression analysis of the collected data. In equation 1 for SEIE rafts and equation 2 for PIWs with S-R streamer, both ALT and LR are measured in units of nmi.

$$Pd(ALT, LR) = \frac{1}{1 + e^{-\left(A \times \sqrt{\left(LR^2 + ALT^2\right)} + K\right)}} \qquad \text{(SEIE rafts)} \qquad (1)$$

$$Pd(ALT, LR) = \frac{1}{1 + e^{-\left(A \times \sqrt{\left((LR - 0.175)^2 + ALT^2\right)} + K\right)}} \qquad \text{(PIWs with S-R streamer)} \qquad (2)$$

4.2.1 Calculation of the A and K Constants for Equations 1 and 2

The value of the coefficient *A* in equations 1 and 2 was an output of the Logit regression model and was determined to be –3.914 for SEIE rafts and –13.882 for PIWs. The value for the coefficient *K* in equations 1 and 2 was produced by output of the Logit regression model coefficients that were found to be statistically significant multiplied by average values of the corresponding variables representing the environmental conditions during the search runs. From the collected data, independent variables were identified for each detection opportunity. On every search leg, an opportunity was defined as a search object having an LR of less than 1.8 nmi. This LR was based on post-test analysis of detections and is equal to 1.5 times the maximum recorded detection range. The following independent variables were identified for each detection opportunity.

- Environmental factors
  - Sky intensity (bright or overcast)
  - Visibility
  - Wind speed
  - Wave height
  - Density of white caps
- Time on task

For each detection, the following independent variables were also identified.

- Crew position
- What was seen first (S-R streamer or target)
- For rafts: presence or absence of S-R streamer

From Logit regression analysis, the following independent variables were determined significant at the 95 percent confidence level for SEIE rafts and for PIWs with the S-R streamer.

- Wind speed (WS)
- Wave height (Hs) as wave height squared
- Visibility (V) as inverse visibility (1/V)

The Logit regression coefficients yielded equation 3 to compute *K* in both equations 1 and 2.

$$K = 3.463 - 0.089 \times WS - 0.117 \times Hs^2 - 10.315 \div V \qquad (3)$$

***Note**: When all raft detection opportunities (both with and without S-R streamer) were evaluated using this methodology, it was determined that the presence of an S-R streamer was not statistically significant as a predictor of Pd vs. LR.*

4.2.2 Validation of the LRC Model

To validate the LRC models developed from the collected data, average values of WS, Hs, and V from the field test were applied to eq. 1 and eq. 2 for various LRs from 0 to 1.8 nmi. Average values for WS, Hs, and V in the data set were determined to be 8.86 knots, 2.55 ft, and, 8.16 nmi, respectively. Average search altitude during the field test was 620 ft for rafts and 627 ft for PIWs. Aircraft search altitude in feet was converted to nmi by dividing by 6000.

Figure 19 shows the modeled LRC for SEIE rafts with and without the S-R streamer when average search variable values from the field test were applied to the model. This figure also contains the binned Pds and their associated 90 percent confidence intervals for SEIE rafts with and without the S-R streamer. The modeled LRC fits within the 90 percent confidence intervals on the raw data. Although the presence of the S-R streamer is not significant in the LRC model, the raw data show that at close lateral ranges, i.e., less than about 0.2 nmi, detection performance was slightly better with the S-R streamer than without it.

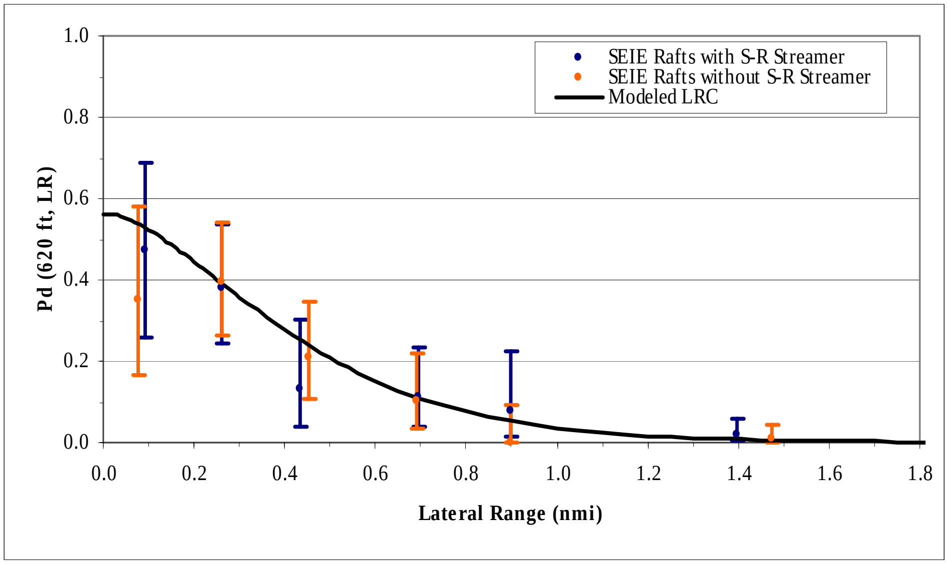

Figure 19. Comparison of field test data for SEIE rafts with and without the S-R streamer against the modeled LRC for SEIE rafts.

Figure 20 shows the modeled LRC for PIWs with S-R streamers when average search variable values from the field test were applied to the model. This figure also contains the binned Pds for PIWs with the S-R streamer and their associated 90 percent confidence intervals. The modeled LRC fits within the 90 percent confidence interval.

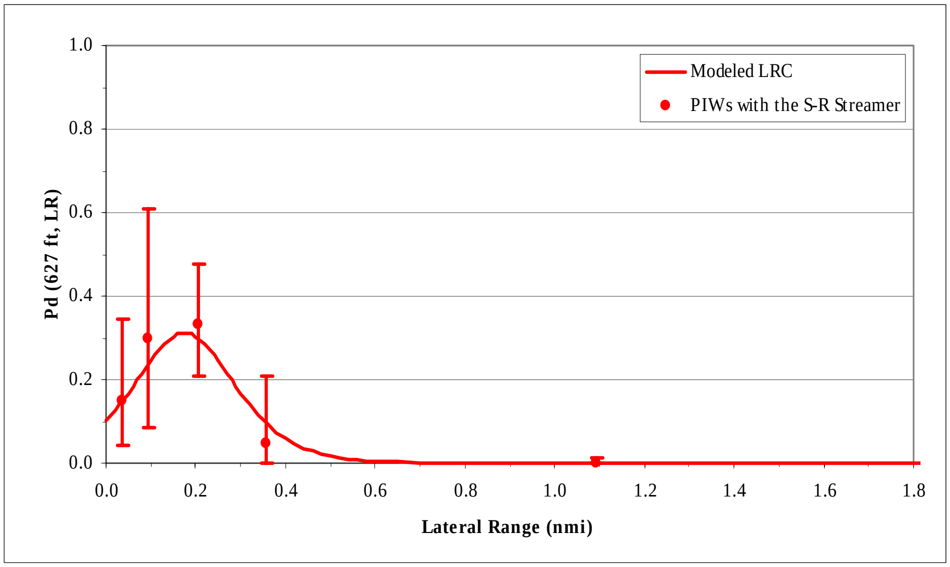

Figure 20. Comparison of field test data for PIWs with the S-R streamer against the modeled LRC for PIWs with the S-R streamer.

4.3 Cumulative Detection Probability

The CDP performance metric was computed from data collected during P-3 and H-53 radial runs with search objects placed at a maximum of 300 yards from the search line. Derivation of CDP required that the collected data be processed to identify detections and non-detections of the search objects and the ranges at which initial detections occurred. Appendix L contains detailed reconstructions of each search leg of CDP testing.

4.3.1 H-53 CDP

4.3.1.1 Daylight Visual Runs

Table 12 provides the results of the CDP analyses for the daylight visual detection runs conducted by the H-53 aircraft flying at a speed of 100 knots and an altitude of 500 feet. The table presents side-by-side comparisons for SEIE rafts with streamers, SEIE rafts without streamers, and PIWs with streamers. The runs were conducted on 28 October 2004, a day with mostly cloudy skies, 7- to 10-knot winds, and waves greater than 5 feet.

Table 12. Summary of search object detections by range bin for the H-53 daylight visual CDP runs.

	Rafts with Streamers			Rafts without Streamers			PIWs with Streamers		
Range Bin (nmi)	Number of Detections	Cumulative Detections	CDP (% Detected)	Number of Detections	Cumulative Detections	CDP (% Detected)	Number of Detections	Cumulative Detections	CDP (% Detected)
0.00–0.25	2	14	52	2	8	44	3	5	28
0.25–0.50	4	12	44	2	6	33	1	2	11
0.50–0.75	2	8	30	2	4	22	1	1	6
0.75–1.00	2	6	22	2	2	11	0	0	0
1.00–1.25	4	4	15	0	0	0	0	0	0
Number of Opportunities	27			18			18		
Average Det Range (nmi)	0.657			0.488			0.310		
Median Det Range (nmi)	0.617			0.490			0.206		
Std Dev of Det Range (nmi)	0.366			0.285			0.240		

As shown in figure 21 for the H-53, the CDP was better for rafts with S-R streamers than it was for the rafts without streamers, suggesting that the S-R streamer definitely helps with survivor relocation by a cued aircraft. Results also showed that both raft CDPs were better than the CDP for PIWs with streamers.

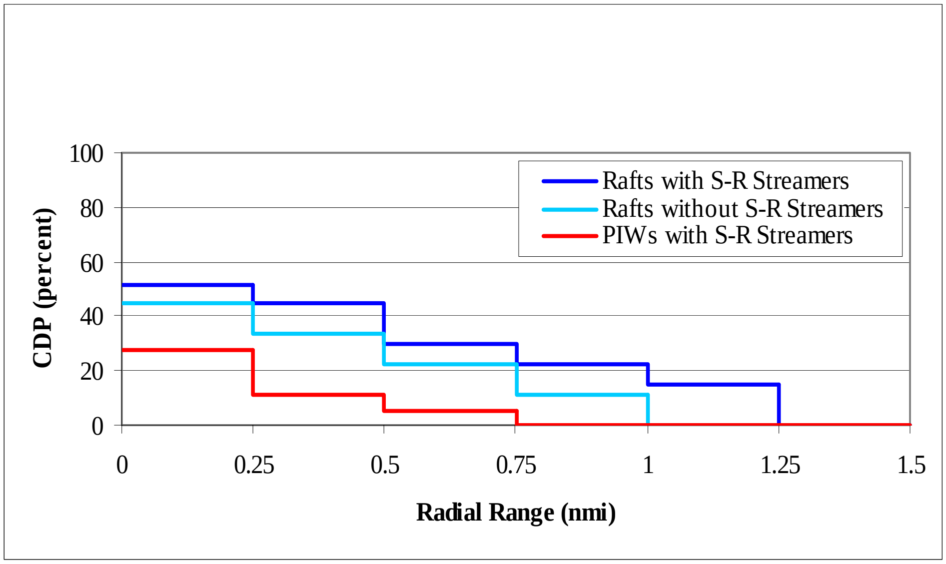

Figure 21. CDP for the H-53 daylight visual CDP runs.

4.3.1.2 Night Vision Goggle Runs

On the evening of 29 October 2004, the H-53 conducted a CDP search using NVGs at 500-foot altitude and 100-knot velocity. No active illumination was employed. Appendix L contains a detailed reconstruction of each search leg of this CDP testing. Not a single valid detection was made during the 29 October test period, even though there were 24 opportunities to detect SEIE rafts with the S-R streamer, 12 opportunities to detect SEIE rafts without the S-R streamer, and 24 opportunities to detect PIWs with the S-R streamer. Poor weather conditions were light rain, 3- to 5-knot winds, and 4.6- to 5.3-foot waves. These conditions were unfavorable for NVG detection of small, unlit search objects.

4.3.2 P-3 Daylight Visual CDP Testing

Tables 13, 14, and 15 provide daylight visual CDP results for the P-3 aircraft flying at 500-, 750-, and 1000-foot altitudes, respectively. Each table presents side-by-side comparisons for SEIE rafts with the S-R streamer, SEIE rafts without the S-R streamer, and PIWs with the S-R streamer. The runs were conducted on 27 April 2004, a day with clear skies, 9.7- to 13.6-knot winds, and waves from 4.9 to 5.6 feet.

Table 13. Summary of search object detections by range bin for the P-3 daylight visual CDP runs conducted at an altitude of 500 feet.

Range Bin (nmi)	Rafts with Streamers			Rafts without Streamers			PIWs with Streamers		
	Number of Detections	Cumulative Detections	CDP (% Detected)	Number of Detections	Cumulative Detections	CDP (% Detected)	Number of Detections	Cumulative Detections	CDP (% Detected)
0.00–0.25	3	21	78	3	5	42	5	12	43
0.25–0.50	4	18	67	0	2	17	5	7	25
0.50–0.75	6	14	52	2	2	17	1	2	7
0.75–1.00	5	8	30	0	0	0	1	1	4
1.00–1.25	3	3	11	0	0	0	0	0	0
Number of Opportunities	27			12			28		
Average Det Range (nmi)	0.619			0.310			0.326		
Median Det Range (nmi)	0.635			0.221			0.261		
Std Dev of Det Range (nmi)	0.338			0.209			0.224		

Table 14. Summary of search object detections by range bin for the P-3 daylight visual CDP runs conducted at an altitude of 750 feet.

Range Bin (nmi)	Rafts with Streamers			Rafts without Streamers			PIWs with Streamers		
	Number of Detections	Cumulative Detections	CDP (% Detected)	Number of Detections	Cumulative Detections	CDP (% Detected)	Number of Detections	Cumulative Detections	CDP (% Detected)
0.00–0.25	2	24	53	1	7	35	7	15	33
0.25–0.50	5	22	49	6	6	30	8	8	18
0.50–0.75	10	17	38	0	0	0	0	0	0
0.75–1.00	5	7	16	0	0	0	0	0	0
1.00–1.25	2	2	4	0	0	0	0	0	0
Number of Opportunities	45			20			45		
Average Det Range (nmi)	0.641			0.367			0.268		
Median Det Range (nmi)	0.663			0.376			0.302		
Std Dev of Det Range (nmi)	0.289			0.102			0.134		

Table 15. Summary of search object detections by range bin for the P-3 daylight visual CDP runs conducted at an altitude of 1000 feet.

Range Bin (nmi)	Rafts with Streamers			Rafts without Streamers			PIWs with Streamers		
	Number of Detections	Cumulative Detections	CDP (% Detected)	Number of Detections	Cumulative Detections	CDP (% Detected)	Number of Detections	Cumulative Detections	CDP (% Detected)
0.00–0.25	1	4	44	0	0	0	0	2	22
0.25–0.50	1	3	33	0	0	0	2	2	22
0.50–0.75	0	2	22	0	0	0	0	0	0
0.75–1.00	1	2	22	0	0	0	0	0	0
1.00–1.25	1	1	11	0	0	0	0	0	0
Number of Opportunities	9			4			9		
Average Det Range (nmi)	0.627			--			0.279		
Median Det Range (nmi)	0.670			--			0.279		
Std Dev of Det Range (nmi)	0.399			--			0.008		

As shown in figures 22, 23, and 24 for the P-3 at all altitudes, the CDP was better for SEIE rafts with the S-R streamer than it was for the rafts without the S-R streamer, suggesting that the S-R streamer improves the chances of survivor relocation by a cued aircraft. Results were comparable for the SEIE rafts without the S-R streamer and the PIWs with the S-R streamer. It should be noted that the number of detection opportunities in the data sets for the 1000-foot altitude runs is very limited, decreasing the amount of confidence that should be placed in those results.

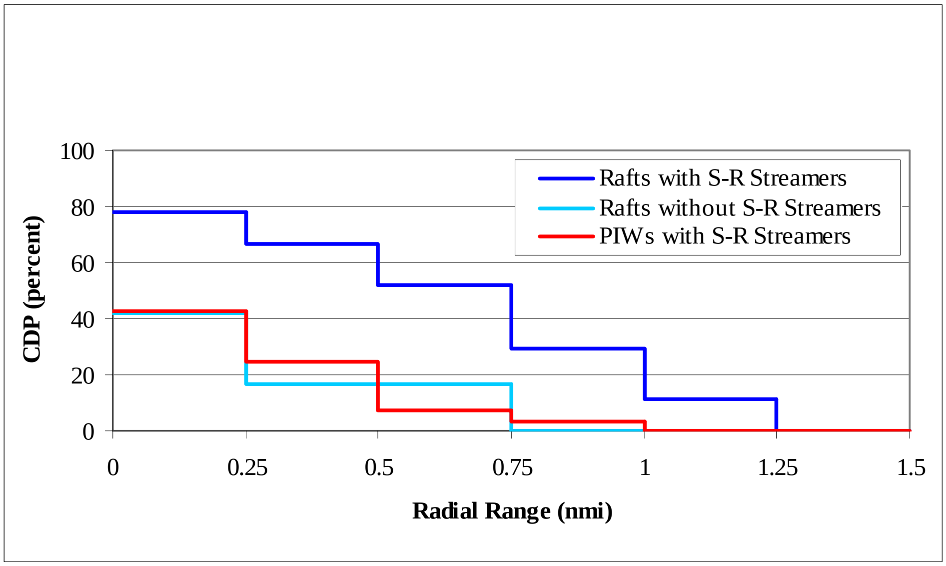

Figure 22. CDP for the P-3 daylight visual CDP runs conducted at 500 feet.

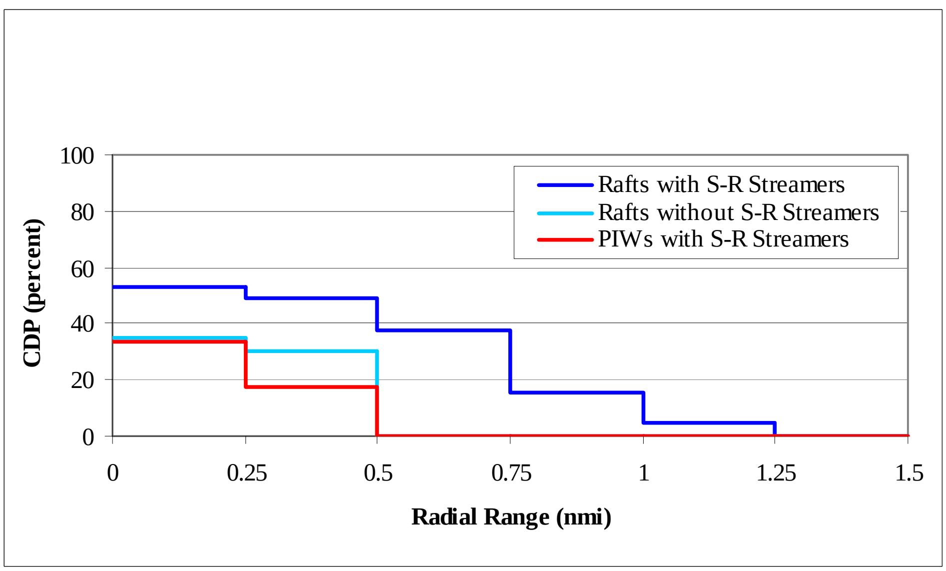

Figure 23. CDP for the P-3 daylight visual CDP runs conducted at 750 feet.

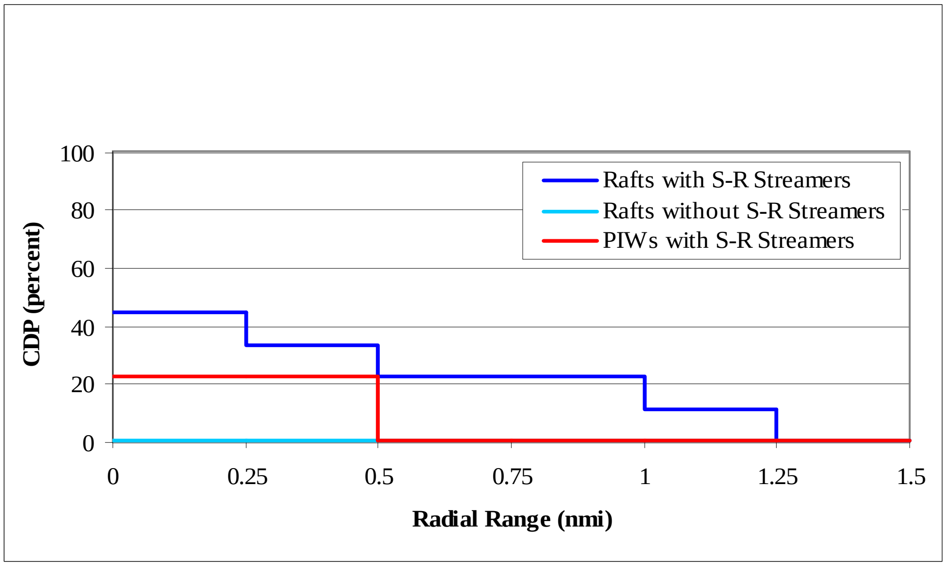

Figure 24. CDP for the P-3 daylight visual CDP runs conducted at 1000 feet.

Data from 27 April 2005 daytime P-3 runs at 200 knots were regrouped by type of search object and plotted to show the effect of altitude on CDP. These figures illustrate that CDP was generally better at the 500-foot altitude than at the 750-foot altitude. Similarly, CDP at the 750-foot altitude was generally better than at the 1000-foot altitude. This analysis refutes an intuitive sense expressed by search crews that higher altitudes were better for searching. Figure 25 is the CDP altitude comparison plot for the SEIE raft with S-R streamer search object. Figure 26 shows the data for the SEIE rafts without S-R streamers, and figure 27 shows the data for the PIWs with S-R streamers.

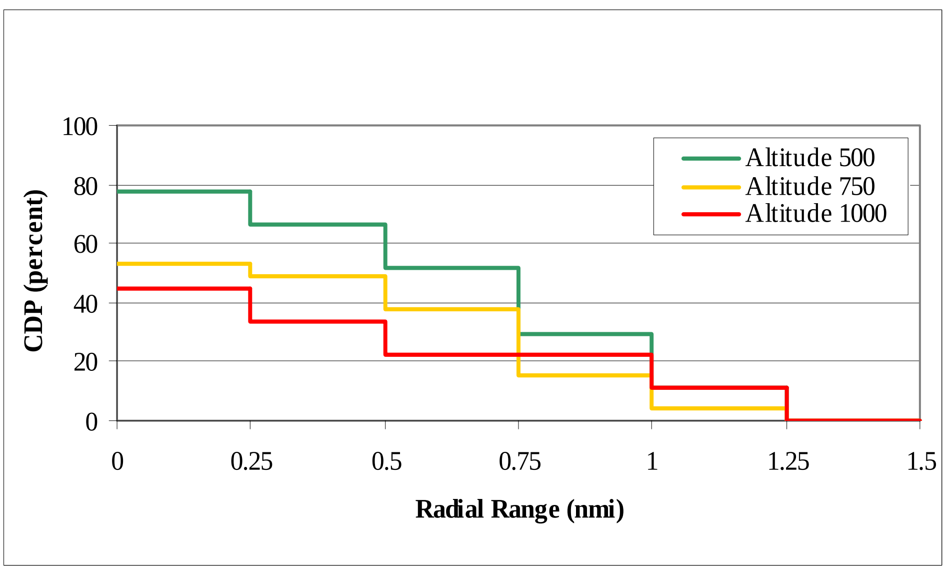

Figure 25. CDP comparison by altitude for SEIE rafts with the S-R streamer.

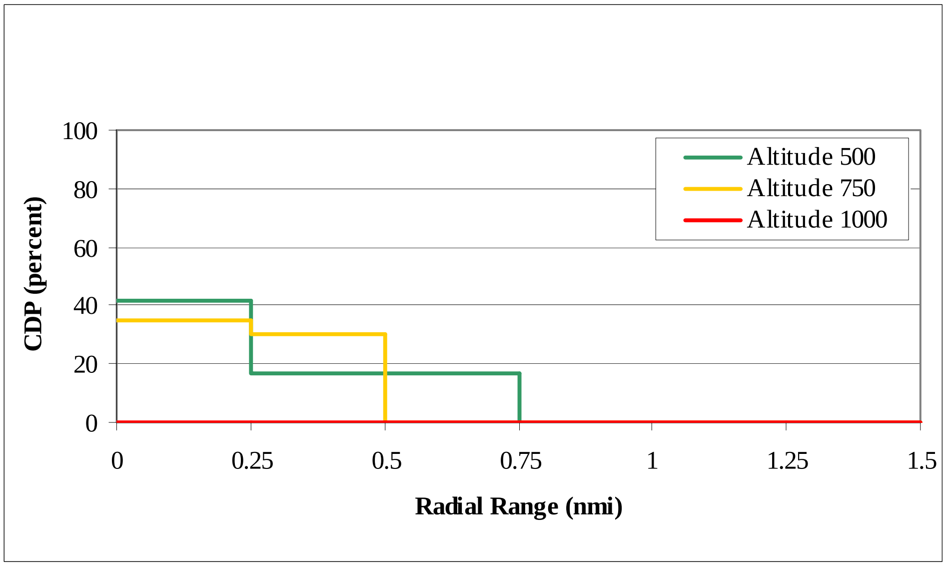

Figure 26. CDP comparison by altitude for SEIE rafts without the S-R streamer.

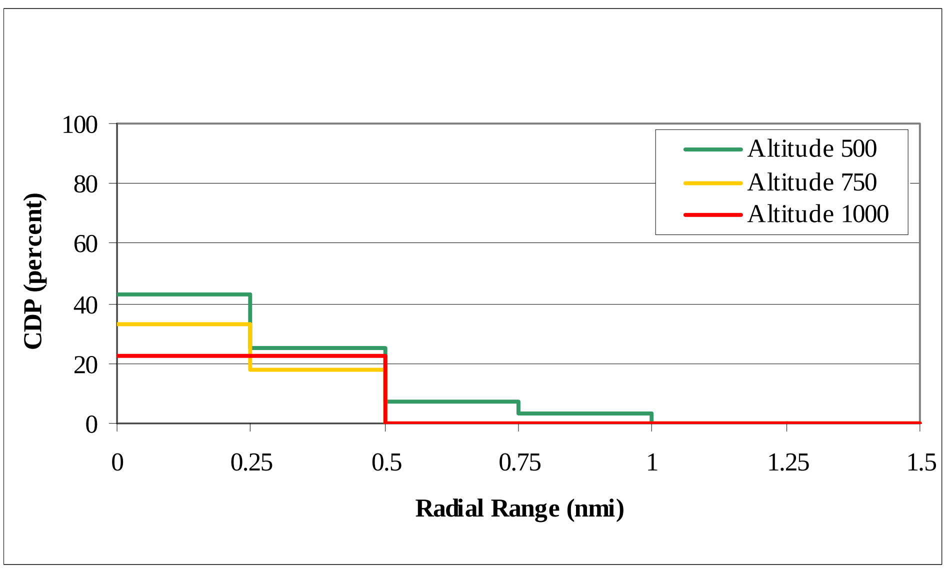

Figure 27. CDP comparison by altitude for PIWs with the S-R streamer.

4.4 LRC Comparison for Search Objects with and without the S-R Streamer

As discussed in section 4.2, the Logit regression analysis disclosed that the presence or absence of the S-R streamer on the SEIE raft was not statistically significant toward development of a model to predict the wide-area search performance of P-3 aircrews. Therefore, a single modeled LRC is used to model P-3 search performance against SEIE rafts with and without the S-R streamers. Sweep width for SEIE rafts with and without streamers was computed as 0.5 nmi for average search conditions encountered during the tests. Careful analysis of several raft Logit regression models revealed no justification from a statistical significance standpoint to create separate LRCs for rafts with and without streamers.

As all the PIW search objects in the field test had S-R streamers, the Logit regression analysis for these data could not directly assess the impact of the streamer on PIW detection performance. However, in the past, the USCG has conducted several field tests with fixed wing aircraft (e.g., HC-130) searching for PIWs that were not using S-R streamers. A modeled LRC for PIWs not using S-R streamers was developed by the RDC from an air search model using all available PIW data taken from many years of USCG RDC field tests. This model was provided as Government-furnished information (GFI) for comparison with the modeled LRC for PIWs using S-R streamers. Average search condition values from this field test were applied to the GFI model to generate the PIW LRC shown in figure 28.

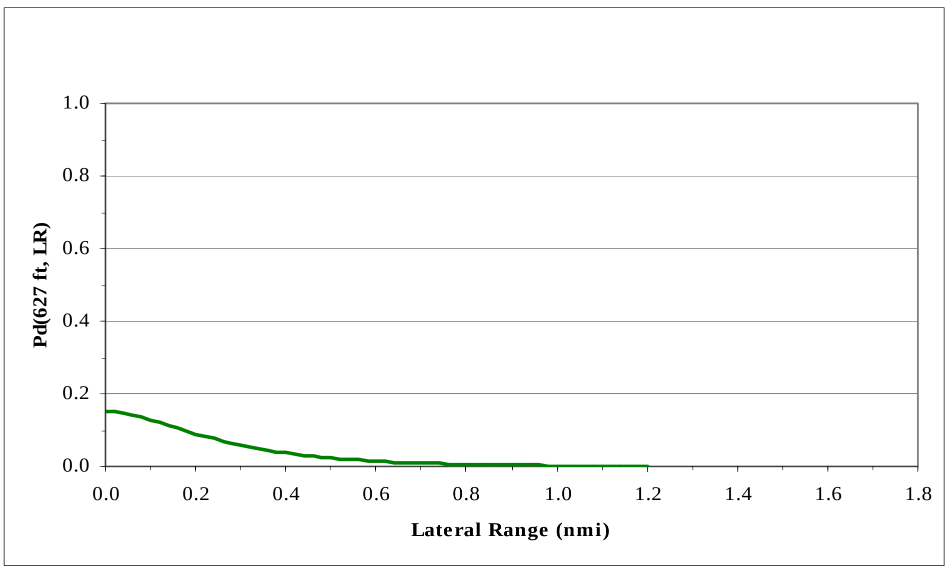

Figure 28. Modeled LRC for USCG aircraft detection of PIWs without the S-R streamer (various field tests; search conditions similar to Navy P-3 test).

Figure 29 compares the LRCs for PIWs without S-R streamers (green) and the PIWs with the S-R streamer (red). The W generated from the LRC modeled for PIWs without streamers is 0.09 nmi, and the W generated from the LRC modeled for PIWs with S-R streamers is 0.17 nmi.

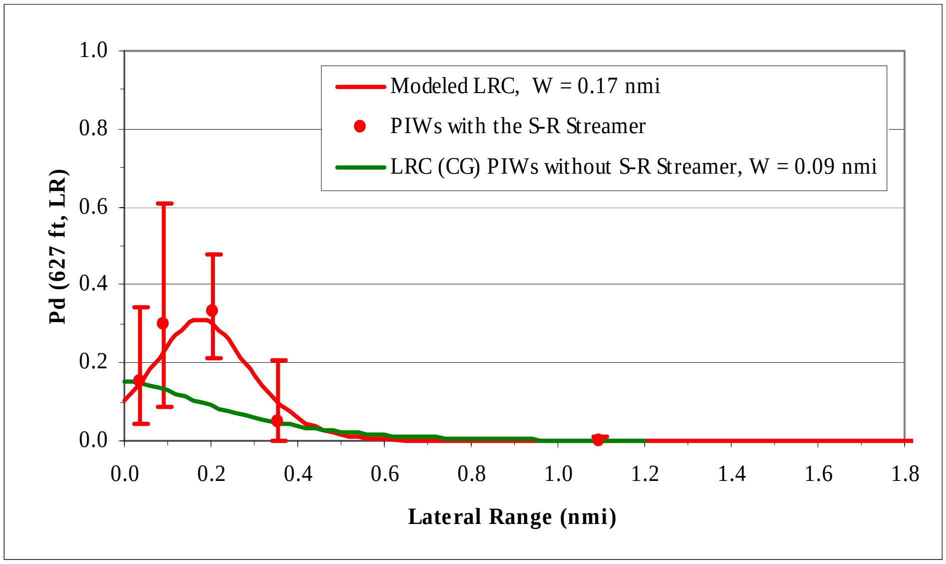

Figure 29. Comparison of field test data for PIWs with the S-R streamer against the USCG RDC data for PIWs without the S-R streamer.

The obvious difference in the two LRCs is that the data from this field test (for PIWs with the S-R streamer) peak at approximately 0.175 nmi while the Coast Guard data (for PIWs without the S-R streamer) monotonically increase as the LR decreases to zero. It is strongly suspected that the difference in curve shapes is due to the design of the aircraft that was used to collect the data. The USCG data were collected primarily from searches conducted with the HC-130 aircraft (see figure 30), which has windows across the entire side and front of the aircraft. Additionally, there are windows at lower levels, down to foot level, so that all crew charged with search responsibilities have an adequate view.

Figure 30. Coast Guard HC-130 aircraft.

In contrast, the P-3 aircraft (see figure 31) does not have any side or lower level windows and only very small side portholes. The nose is shaped so that searching at close ranges is very difficult for the pilots, who must perform other tasks in addition to searching.

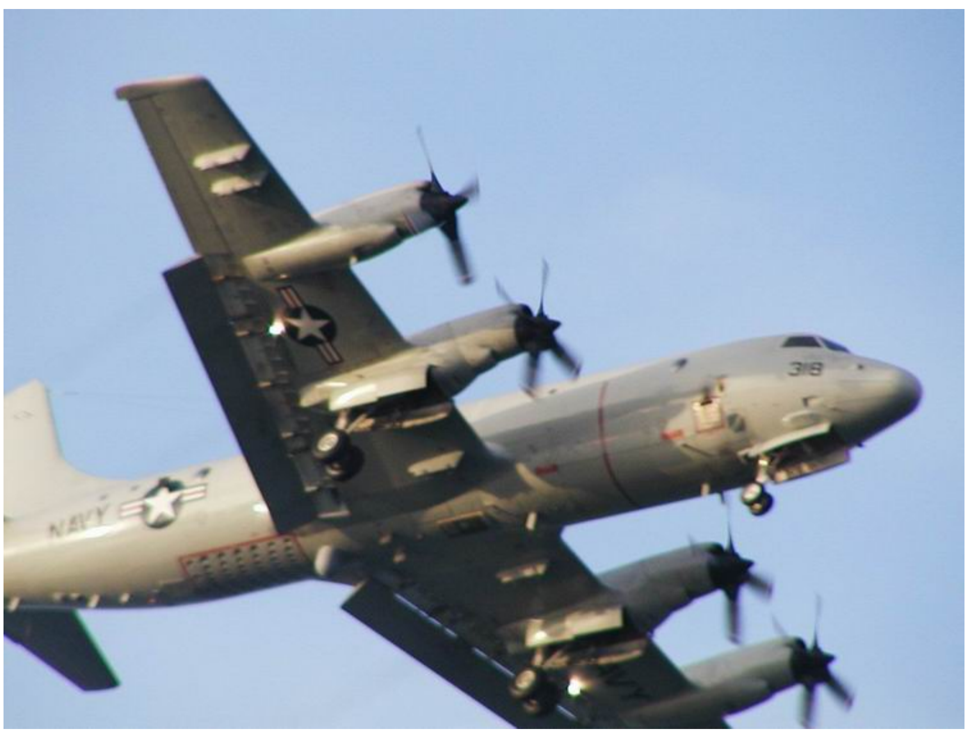

Figure 31. P-3 aircraft.

At lateral ranges between approximately 0.1 and 0.4 nmi, the LRC for the PIWs with the S-R streamer is higher than that for the PIWs without the S-R streamer, indicating that the streamer enhances PIW detectability at closer lateral ranges.

As another indication that the S-R streamer enhances PIW detection, the CDP data showed that the results for the PIWs with the S-R streamer are comparable to those for the SEIE rafts without the S-R streamer (a substantially larger search object). These data also indicate that it is realistic to expect better detection performance against the PIWs with the S-R streamer.

5. Conclusions and Recommendations

This chapter presents conclusions drawn from the analyzed data. From these conclusions, recommendations are presented for the employment of the S-R streamer with SEIE rafts and other small low-observable targets, such as PIWs.

5.1 Conclusions

The S-R streamer **does not** appear to improve search performance against SEIE rafts during area searches by fixed wing aircraft flying at 200 knots. The Logit analysis used to develop the LRC from the Pd vs. LR data collected during the field test disclosed that the presence or absence of the S-R streamer on the SEIE raft was not statistically significant in the LRC prediction model.

The S-R streamer **does** appear to improve search performance against PIWs during area searches by fixed wing aircraft flying at 200 knots. Comparison of the LRC model developed from Logit analysis of the P-3 data (vs. the PIW with S-R streamer target) with the LRC developed from CG field data (vs. PIWs without the S-R streamer) reveals that, other factors being equal, significantly better search performance can be expected against PIWs with the S-R streamer.

The Logit analysis also showed that aircraft altitude, wave height, visibility, and wind speed exerted statistically significant influence on the P-3 aircrews' ability to detect all search objects.

The CDP function for SEIE rafts with S-R streamer was significantly better than for SEIE rafts without the S-R streamer. The S-R streamer on PIWs enhanced CDP to a level similar to that for SEIE rafts without the S-R streamer. These results suggest that the S-R streamer significantly enhances the ability of cued rescue aircraft crews to locate survivors.

Contrary to aircrew expectations, CDPs were better for lower altitude searches than for higher altitude searches for all search objects tested.

In adverse conditions that included no active illumination, light rain, 3- to 5-knot winds, and 4.6- to 5.3-foot waves, the S-R streamer did not facilitate search object detection by NVGs.

Detection of distant targets was not influenced by the S-R streamer; it is thought that other factors such as target freeboard, color contrast, and geometric shape influenced distant target detection. In addition, the impact of the S-R streamer may be degraded by its "floating" approximately 1 inch below the surface.

The SEIE raft tendency to align perpendicular to waves and wind may result in a very uncomfortable experience for survivors. The under-seat sea anchor attachment point results in a tendency for the raft to orient a survivor's back to the waves and wind. However, the torso bubble in the raft acts as a sail that attempts to force the raft to ride with a survivor's feet into the wind. The result of these forces is for the raft to ride perpendicular to waves and wind.

Twisting of the S-R streamer may decrease its effectiveness. Twisting results in a significant decrease in the visible area of the streamer.

S-R streamer deployment requires a fully conscious and uninjured survivor. An injured or impaired survivor will likely find deployment of the streamer difficult.

5.2 Recommendations

Based on data analysis, the following recommendations are made.

- Update NWP 3-50.1 and National SAR Supplement with new W estimates for SEIE raft without streamer and PIW with S-R streamer in accordance with the specific recommendations provided in appendix M.

- Update Navy Search and Rescue (SAR) Doctrine to emphasize the importance of low altitude when searching for low-observable targets such as the SEIE raft.

- Consider further testing focused on NVG detection of PIWs and SEIE rafts with and without S-R streamer. Both passive search and active illumination should be tested.

- Navy decision makers should weigh the SAR mission performance improvements provided by the S-R streamer against improvements that could be provided by alternative distress signaling equipment.

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Edwards, N.C., Osmer, S.R., Mazour, T.J., and Bouthilette, D.B. (1978). Analysis of Visual Detection Performance (Fall 1978 Experiment). Report No. CG-D-03-79. USCG Research and Development Center and Analysis & Technology, Inc., December 1978.

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APPENDIX A SEARCH OBJECT DESCRIPTIONS

A.1 SEIE RAFTS

The SEIE raft is a one-person, self-inflating raft intended for use by survivors of a submarine accident. In a submarine accident, sailors will don an escape survival suit while still in the submarine. Several sailors at a time will enter the submarine escape trunk, which will be pressurized and flooded in less than 30 seconds. Once the escape hatch opens, the escape survival suit will jettison the sailor to the surface of the ocean at a rate of 400 feet per minute. Once on the surface, the sailor will inflate the SEIE raft using a ripcord-like device. The sailor will climb into the SEIE raft and secure the canopy of the raft using Velcro fasteners. A picture of the SEIE raft with a person inside is presented in Figure A-1. Figure A-2 shows the SEIE raft free floating with a person embarked and S-R streamer deployed; the wind in this picture is moving left to right. The raft floats perpendicular to the wind with the S-R streamer flowing into the wind.

Figure A-1. Person inside SEIE raft.

Figure A-2. Free-floating SEIE raft with person embarked and S-R streamer deployed.

For these tests, the SEIE rafts were ballasted to simulate a person sitting in the raft. The canopy of the SEIE raft was held up using a Styrofoam block to simulate a human sitting inside. The SEIE rafts were anchored to ensure that their positions were known. Figure A-3 shows an anchored SEIE raft with S-R streamer.

Figure A-3. SEIE raft with S-R streamer anchored as search object.

A.2 S-R STREAMER

The S-R streamer is constructed of high-strength orange polyethylene and marked with the international distress symbol. The streamers used for this test were 6 inches wide by 25 feet long. Each streamer was enhanced with six 1-inch strips of retro-reflective tape (three strips per side). The S-R streamer was attached to the search object at a point above the water line. A picture of the S-R streamer is presented in Figure A-4.

The S-R streamer comes packaged in a roll that has to be unfurled; once unfurled, the streamer will deploy. The S-R streamer has a quick-connect clip on one end that is used to attach it to the search object. On the SEIE rafts, the S-R streamer was attached to the starboard (right) strap of the SEIE raft. On the PIW search objects, the S-R streamer was attached to the PFD waist strap or the lifting strap on its back.

Figure A-4. See/Rescue® streamer.

A.3 PIWS

PIWs were simulated using mannequins wearing Navy standard PFDs. The mannequins were ballasted using cement sea anchors to simulate a human floating in the ocean. The PIWs were anchored to ensure that positions were known. A typical PIW search object (wearing a Navy PFD) is presented in Figure A-5. Figure A-6 shows the PIW search object with an S-R streamer.

Figure A-5. PIW search object.

Figure A-6. PIW search object with S-R streamer.

APPENDIX B LATERAL RANGE CURVE, SWEEP WIDTH, AND CUMULATIVE PROBABILITY OF DETECTION

B.1 LATERAL RANGE CURVE AND SWEEP WIDTH

During the World War II time frame, B.O. Koopman developed the concept of the lateral range curve (LRC) to describe the cumulative detection probability (CDP) of a target during one complete transit of an infinitely long straight track as a function of the perpendicular distance from the track to the target. Sweep width (W) is the area under the LRC corresponding to a particular sensor/target/environment situation. In A Brief History of Search Theory and Practice, Soza & Company, Ltd. explain "It is the cumulative effect of the overlapping tails of infinitely many such LRCs centered on adjacent parallel tracks and averaged across the space between tracks which produces the probability of detection (POD) vs. Coverage Factor curve in the National Search and Rescue Manual (NSM)."

Lateral range (LR) is defined as the least distance between a target and an observer. An LRC plots Pd versus lateral range. Because most search plans involve parallel track searches, the range at the closest point of approach (CPA) is equivalent to lateral range. Figure B-1 illustrates a search and rescue unit (SRU) passing by a search target at CPA (lateral range).

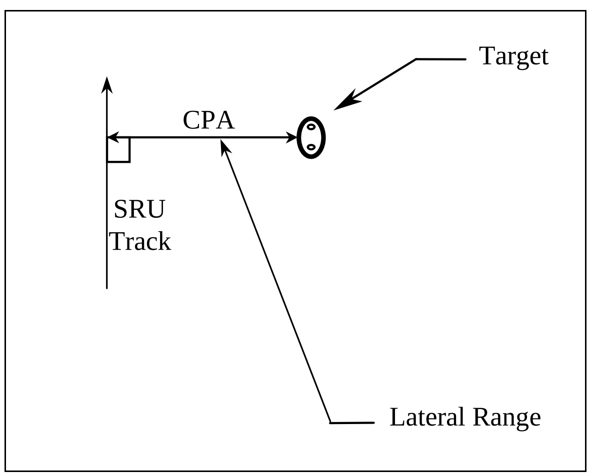

Figure B-1. Definition of lateral range.

Figure B-2 shows a search LRC. The curve plots the probability of detecting the target as a function of LR, i.e., CPA. To compare the range of detections and missed detection opportunities equitably, the lateral range is computed for all target detection opportunities.

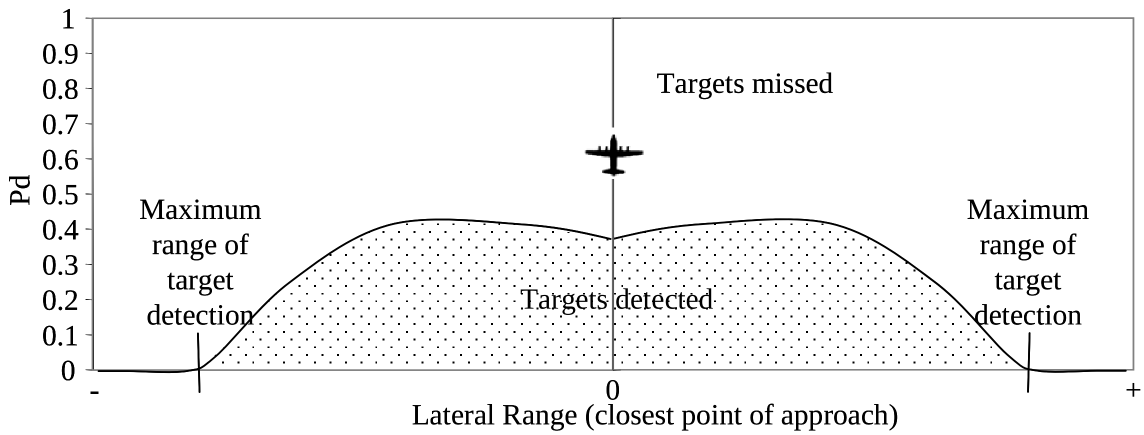

Figure B-2. Sample lateral range curve.

Mathematically, W is the integral of Pd as a function of lateral range over all possible lateral range values (equation 1).

$$W = \int_{-\infty}^{+\infty} Pd(x)\, dx \qquad \text{equation 1}$$

Where:

W = Sweep width.

x = Lateral range (i.e., CPA) to targets of opportunity, and

Pd(x) = Target detection probability of lateral range x.

W, shown in Figure B-3, is the lateral range where the probability of targets detected outside the W (2 grey patterned areas) is the same as the probability of missed targets inside the W (solid grey area). W is used to determine search track spacing.

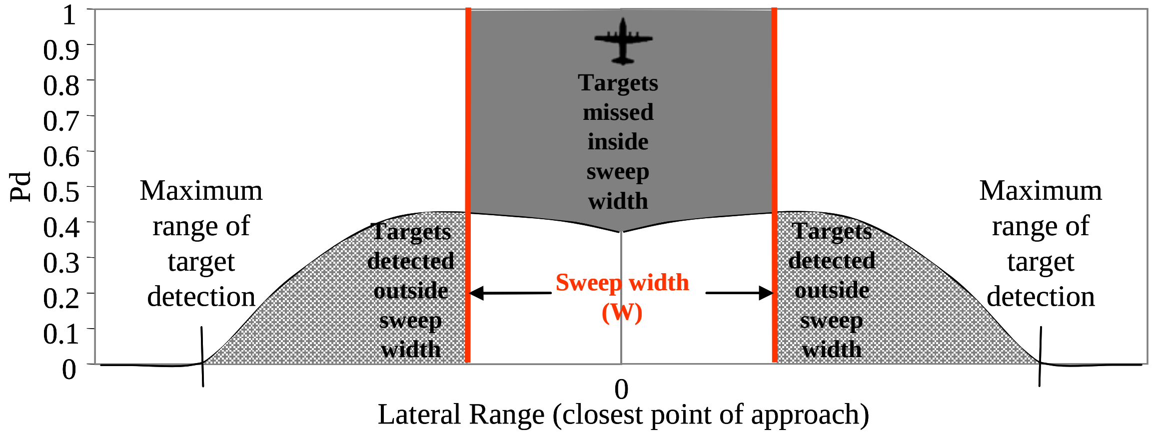

Figure B-3. Sweep width diagram.

Figure B-4 illustrates the case in which an A/C SRU is flying a straight search track. The W is much less than twice the maximum detection range. Because Pd is less than 50 percent outside the W and approaches zero at the maximum detection range, this area outside of the W should be swept again on the next leg of the search pattern.

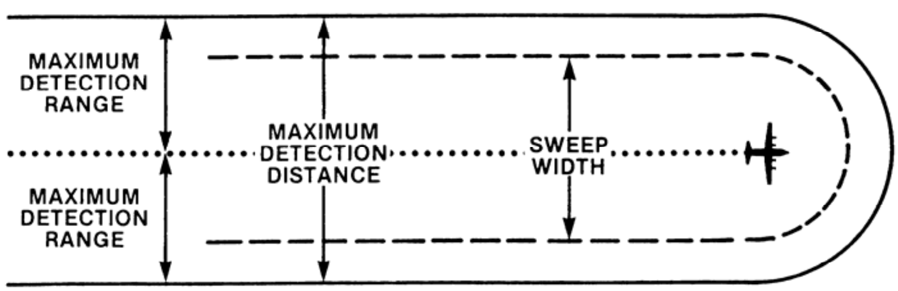

Figure B-4. Maximum detection distance vs. sweep width.

For this field test, visual W testing and associated data collection was conducted in a manner that allowed LRCs and Ws to be determined for naval P-3 aircrews using their unaided eyes during daytime search for SEIE rafts with and without S-R streamers and for PIW search objects with S-R streamers. All data was entered into a spreadsheet that, for each detection opportunity, included the target type, CPA range, flag denoting if a detection was made, altitude, wind speed, wave height, visibility, and other parameters of interest. SYSTAT® LOGIT multivariate logistic regression model (refer to appendix K) was used to generate coefficients to develop a smooth LRC from these field test data. These coefficients define the probability of detection (Pd) as a function of LR, altitude, wind speed, wave height, and visibility. Average altitude, wind speed, wave height, and visibility of all detection opportunities is used with the coefficients to develop the LRC. The LRC developed from this process is used to specify Pd at small intervals of LR (i.e., .01 nmi). The area under the LRC (i.e., the integral of the LRC) is computed by summing the product of each Pd multipled by its interval width.

B.2 CUMULATIVE DETECTION PROBABILITY

The CDP curve is derived from detection data collected when a search platform is driven toward a target or group of targets. The CPA or lateral range is very small with respect to detection range. The searcher knows where to look to make the detection. This detection data is used to create a CDP curve. A CDP curve is used to quantify expected survivor acquisition ranges as a function of weather, search altitude, and lighting conditions.

The following example shows how a CDP curve is developed. Suppose a small, difficult to detect target was closed 20 times and 19 detections were made with the data shown in Table B-1.

Table B-1. Detection Data.

Detection Opportunity	**Detection Range (nmi)**
1	0.50
2	0.40
3	0.60
4	0.80
5	0.90
6	No detection
7	0.45
8	0.49
9	1.00
10	0.59
11	0.51
12	0.65
13	0.75
14	0.33
15	0.83
16	0.91
17	0.58
18	0.39
19	0.44
20	0.15

The detections are shown sorted by decreasing range in Table B-2.

Table B-2. Detections sorted by decreasing range.

Detection Opportunity	**Detection Range**
1	1.00
2	0.91
3	0.90
4	0.83
5	0.80
6	0.75
7	0.65
8	0.60
9	0.59
10	0.58
11	0.51
12	0.50
13	0.49
14	0.45
15	0.44
16	0.40
17	0.39
18	0.33
19	0.15
20	No detection

The CDP curve (Table B-3 and Figure 4) is built from the assumption that 1 out of 20 will be detected by 1 nmi, 2 out of 20 by 0.91 nmi, 3 out of 20 by 0.9 nmi, etc., until 19 out of 20 are detected by 0.15 nmi.

Table B-3. CDP data.

Detection Range (nmi)	**Cumulative Number of Detections**	**CDP**
1.00	1 of 20	0.05
0.91	2 of 20	0.10
0.90	3 of 20	0.15
0.83	4 of 20	0.20
0.80	5 of 20	0.25
0.75	6 of 20	0.30
0.65	7 of 20	0.35
0.60	8 of 20	0.40

Detection Range (nmi)	Cumulative Number of Detections	CDP
0.59	9 of 20	0.45
0.58	10 of 20	0.50
0.51	11 of 20	0.55
0.50	12 of 20	0.60
0.49	13 of 20	0.65
0.45	14 of 20	0.70
0.44	15 of 20	0.75
0.40	16 of 20	0.80
0.39	17 of 20	0.85
0.33	18 of 20	0.90
0.15	19 of 20	0.95

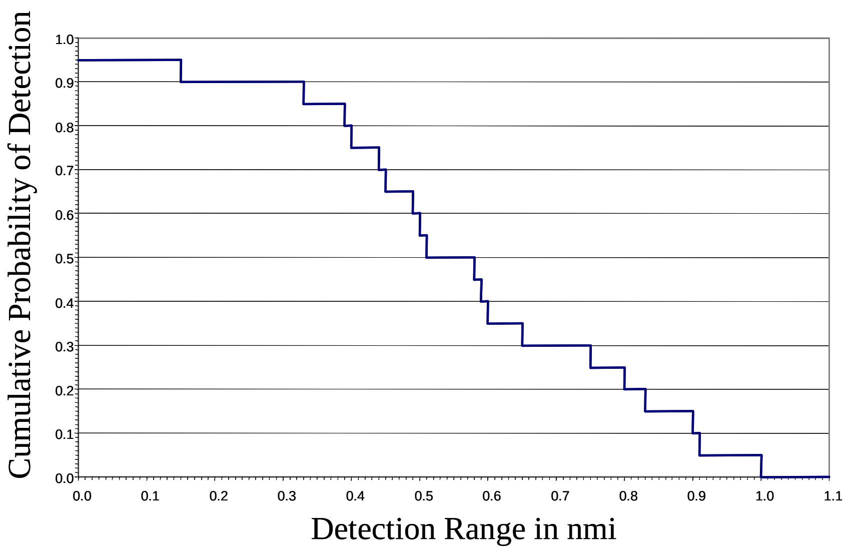

Figure B-5. CDP curve.

APPENDIX C SEE/RESCUE® QUICKLOOK REPORT #1 SEARCH OBJECT VALIDATION

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APPENDIX D TEST PLAN: NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY SEE/RESCUE® STREAMER TARGET DETECTABILITY TESTING

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APPENDIX E SEE/RESCUE® STREAMER TARGET DETECTABILITY TESTING (FALL)

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APPENDIX F QUICKLOOK REPORT #2 AUTUMN FIELD TEST

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APPENDIX G SEE/RESCUE® STREAMER TARGET DETECTABILITY TESTING (SPRING)

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APPENDIX H ENVIRONMENTAL CONDITIONS

Table H- 1. Environmental conditions for 28 October 2004.

Time (EDT)	Temperature (°F)	Dew Point (°F)	Humidity (%)	Pressure (In)	Visibility (Miles)	Wind Direction	Wind Speed (MPH)	Gust Speed (MPH)	Precipitation (In)	Events	Conditions
12:53 AM	41	41	100	30.22	8	Calm	Calm	-	N/A		Clear
1:53 AM	41	41	100	30.23	8	Calm	Calm	-	0.01		Clear
2:53 AM	45	45	100	30.24	6	NW	3.5	-	N/A		Mist
3:53 AM	46	46	100	30.22	7	NW	4.6	-	N/A		Clear
4:53 AM	46	46	100	30.24	7	NNW	4.6	-	N/A		Clear
5:53 AM	46.9	46.9	100	30.26	6	NNW	5.8	-	N/A		Mist
6:53 AM	46.9	46.9	100	30.26	5	NNW	4.6	-	N/A		Mist
7:53 AM	48.9	48	97	30.27	6	NNW	5.8	-	N/A		Mist
8:53 AM	52	51.1	97	30.3	7	North	5.8	-	N/A		Partly Cloudy
9:53 AM	57	53.1	87	30.3	10	North	9.2	-	N/A		Mostly Cloudy
10:53 AM	59	50	72	30.31	10	ENE	8.1	-	N/A		Mostly Cloudy
11:53 AM	59	48.9	69	30.31	10	ENE	10.4	-	N/A		Mostly Cloudy
12:12 PM	60.8	48.2	63	30.3	10	ENE	9.2	-	N/A		Mostly Cloudy

Table H- 1. Environmental conditions for 28 October 2004. (Cont'd)

Time (EDT)	Temperature (°F)	Dew Point (°F)	Humidity (%)	Pressure (In)	Visibility (Miles)	Wind Direction	Wind Speed (MPH)	Gust Speed (MPH)	Precipitation (In)	Events	Conditions
12:23 PM	59	48.2	67	30.3	10	NNE	10.4	-	N/A		Mostly Cloudy
12:34 PM	57.2	48.2	72	30.3	10	NE	9.2	-	N/A		Mostly Cloudy
12:53 PM	60.1	48.9	67	30.29	10	ENE	11.5	-	N/A		Mostly Cloudy
1:53 PM	59	48	67	30.27	10	NE	10.4	-	N/A		Mostly Cloudy
2:53 PM	59	48.9	69	30.26	10	NE	10.4	-	N/A		Mostly Cloudy
3:07 PM	57.2	48.2	72	30.27	10	ENE	11.5	-	N/A		Scattered Clouds

Table H- 2. Environmental conditions for 29 October 2004.

Day	Time (EDT)	Air Temp (°F)	Dew Point (°F)	Humidity (%)	Pressure (In)	Sea Temp (°F/°C)	Wave Period (sec)	Wave Height (ft/m)	Visibility (Miles)	Wind Dir	Wind Spd	Precip (In)	Events
29-Oct	1:53 AM	53.1	46.9	80	30.23	60 / 16	11	5.25 / 1.60	10	SE	5.8		Mostly Cloudy
29-Oct	2:53 AM	54	48	80	30.21	60 / 16	11	5.25 / 1.60	10	SE	3.5		Overcast
29-Oct	3:53 AM	55	48.9	80	30.19	60 / 16	11	5.58 / 1.70	10	South	3.5		Overcast
29-Oct	4:53 AM	48.9	48	97	30.19	60 / 16	11	5.58 / 1.70	10	Calm	Calm		Overcast
29-Oct	5:53 AM	50	48.9	96	30.18	60 / 16	11	5.58 / 1.70	10	Calm	Calm		Overcast
29-Oct	6:53 AM	50	48.9	96	30.18	60 / 16	13	4.92 / 1.50	10	Calm	Calm		Overcast
29-Oct	7:53 AM	50	48.9	96	30.17	60 / 16	13	5.58 / 1.70	10	Calm	Calm		Overcast
29-Oct	8:53 AM	55	53.1	93	30.17	60 / 16	13	5.58 / 1.70	10	Calm	Calm		Overcast
29-Oct	9:53 AM	57.9	53.1	84	30.17	60 / 16	13	5.58 / 1.70	10	Variable	3.5		Overcast
29-Oct	10:53 AM	60.1	54	80	30.16	60 / 16	13	5.25 / 1.60	10	SSW	5.8		Overcast
29-Oct	11:53 AM	60.1	54	80	30.14	61 / 16	13	5.58 / 1.70	10	SSW	8.1		Mostly Cloudy
29-Oct	12:53 PM	60.1	54	80	30.09	61 / 16	13	5.25 / 1.60	10	South	8.1		Overcast
29-Oct	1:53 PM	60.1	55.9	86	30.07	61 / 16	13	5.25 / 1.60	10	SSW	9.2		Overcast
29-Oct	2:53 PM	59	54	83	30.06	61 / 16	11	4.92 / 1.50	10	SSW	9.2		Overcast
29-Oct	3:53 PM	59	55	87	30.05	61 / 16	11	4.92 / 1.50	10	SSW	6.9		Overcast

Table H- 2. Environmental conditions for 29 October 2004. (Cont'd)

Day	Time (EDT)	Air Temp (°F)	Dew Point (°F)	Humidity (%)	Pressure (In)	Sea Temp (°F/°C)	Wave Period (sec)	Wave Height (ft/m)	Visibility (Miles)	Wind Dir	Wind Spd	Precip (In)	Events
29-Oct	4:53 PM	59	54	83	30.04	61 / 16	11	4.92 / 1.50	10	SSW	6.9		Overcast
29-Oct	5:53 PM	57.9	52	81	30.04	61 / 16	13	4.92 / 1.50	10	SSW	9.2		Overcast
29-Oct	6:53 PM	57	53.1	87	30.04	61 / 16	10	4.59 / 1.40	10	SW	5.8		LightRain
29-Oct	7:53 PM	57	55	93	30.05	61 / 16	13	4.92 / 1.50	10	SW	4.6		LightRain
29-Oct	8:53 PM	57	55	93	30.05	61 / 16	13	5.25 / 1.60	8	SSW	3.5		LightRain
29-Oct	9:53 PM	57	55.9	96	30.04	61 / 16	13	4.59 / 1.40	10	SSW	6.9		LightRain
29-Oct	10:53 PM	57	57	100	30.02	61 / 16	13	4.59 / 1.40	7	SSW	6.9		Overcast
29-Oct	11:53 PM	57	57	100	30.01	61 / 16	13	4.92 / 1.50	7	SSW	8.1		Overcast

Table H- 3. Environmental conditions for 01 November 2004.

Time (EDT)	Temperature (°F)	Dew Point (°F)	Humidity (%)	Pressure (In)	Visibility (Miles)	Wind Direction	Wind Speed (MPH)	Gust Speed (MPH)	Precipitation (In)	Events	Conditions
12:53 AM	50	44.1	80	30.01	10	WNW	4.6	-	N/A		Clear
1:53 AM	50	44.1	80	30.02	10	WNW	4.6	-	N/A		Clear
2:53 AM	50	43	77	30.03	10	WNW	5.8	-	N/A		Clear
3:53 AM	53.1	39.9	61	30.04	10	West	4.6	-	N/A		Clear
4:53 AM	51.1	39	63	30.06	10	NW	8.1	-	N/A		Clear
5:53 AM	54	39	57	30.08	10	NNW	8.1	-	N/A		Clear
6:53 AM	53.1	39.9	61	30.1	10	NW	5.8	-	N/A		Clear
7:53 AM	57.9	42.1	56	30.13	10	NNW	8.1	-	N/A		Clear
8:53 AM	61	42.1	50	30.13	10	NNW	10.4	-	N/A		Clear
9:53 AM	64	41	43	30.14	10	North	11.5	19.6	N/A		Clear
10:53 AM	66.9	41	39	30.14	10	NNW	11.5	-	N/A		Clear
11:53 AM	68	41	37	30.12	10	NNW	6.9	-	N/A		Clear
12:53 PM	70	39	32	30.12	7	WNW	11.5	-	N/A		Clear
1:53 PM	71.1	37.9	30	30.1	10	NW	10.4	16.1	N/A		Clear
2:53 PM	69.1	37	31	30.11	10	WNW	8.1	-	N/A		Clear
3:53 PM	61	52	72	30.12	10	ESE	9.2	-	N/A		Clear

Table H- 3. Environmental conditions for 01 November 2004. (Cont'd)

Time (EDT)	Temperature (°F)	Dew Point (°F)	Humidity (%)	Pressure (In)	Visibility (Miles)	Wind Direction	Wind Speed (MPH)	Gust Speed (MPH)	Precipitation (In)	Events	Conditions
4:53 PM	57	52	83	30.13	10	East	4.6	-	N/A		Clear
5:53 PM	57	51.1	81	30.15	10	SE	3.5	-	N/A		Clear
6:53 PM	52	50	93	30.17	10	Calm	Calm	-	N/A		Clear
7:53 PM	50	48.9	96	30.17	10	Calm	Calm	-	N/A		Clear
8:53 PM	48.9	48.9	100	30.18	10	Calm	Calm	-	N/A		Clear
9:53 PM	48.9	48.9	100	30.18	9	Calm	Calm	-	N/A		Partly Cloudy
10:53 PM	50	48.9	96	30.18	10	Calm	Calm	-	N/A		Clear
11:53 PM	48	48	100	30.18	9	Calm	Calm	-	N/A		Clear

Table H- 4. Environmental conditions for 02 November 2004.

Time (EDT)	Temp (°F)	Dew Point (°F)	Humidity (%)	Pressure (In)	SST F/C	Wave Period	Wave ht (ft/m)	Visibility (Miles)	Wind Dir	Wind Speed (MPH)	Precipitation (In)	Conditions
2:53 PM	69.1	37	31	30.11	61 / 16	4	2.95 / 0.90	10	WNW	8.1	N/A	Clear
3:53 PM	61	52	72	30.12	61 / 16	4	2.62 / 0.80	10	ESE	9.2	N/A	Clear
4:53 PM	57	52	83	30.13	61 / 16	4	2.30 / 0.70	10	East	4.6	N/A	Clear
5:53 PM	57	51.1	81	30.15	61 / 16	4	1.97 / 0.60	10	SE	3.5	N/A	Clear
6:53 PM	52	50	93	30.17	60 / 16	14	1.64 / 0.50	10	Calm	Calm	N/A	Clear
7:53 PM	50	48.9	96	30.17	60 / 16	6	1.64 / 0.50	10	Calm	Calm	N/A	Clear
8:53 PM	48.9	48.9	100	30.18	60 / 16	5	1.64 / 0.50	10	Calm	Calm	N/A	Clear
9:53 PM	48.9	48.9	100	30.18	60 / 16	7	1.31 / 0.40	9	Calm	Calm	N/A	Partly Cloudy
10:53 PM	50	48.9	96	30.18	60 / 16	5	1.31 / 0.40	10	Calm	Calm	N/A	Clear
11:53 PM	48	48	100	30.18	60 / 16	6	1.31 / 0.40	9	Calm	Calm	N/A	Clear
12:53 AM	46.0	46.0	100%	30.17	60 / 16	7	1.31 / 0.40	10.0	ENE	4.6	N/A	Clear
1:53 AM	57.9	53.1	84%	30.17	60 / 16	14	1.31 / 0.40	10.0	East	6.9	N/A	Overcast
2:53 AM	57	51.1	81%	30.17	60 / 16	7	1.64 / 0.50	10	ESE	6.9	N/A	Scattered Clouds
3:53 AM	57.9	50.0	75%	30.18	60 / 16	3	1.97 / 0.60	10	SE	5.8	N/A	Mostly Cloudy
4:53 AM	57.9	51.1	78%	30.17	60 / 16	3	1.97 / 0.60	10	SE	4.6	N/A	Partly Cloudy
5:53 AM	59	53.1	81%	30.17	60 / 16	4	1.97 / 0.60	10.0	ESE	8.1	N/A	Mostly Cloudy
6:53 AM	59.0	53.1	81%	30.18	60 / 16	4	1.97 / 0.60	10.0	ESE	9.2	N/A	Overcast

Table H- 4. Environmental conditions for 02 November 2004. (Cont'd)

Time (EDT)	Temp (°F)	Dew Point (°F)	Humidity (%)	Pressure (In)	SST F/C	Wave Period	Wave ht (ft/m)	Visibility (Miles)	Wind Dir	Wind Speed (MPH)	Precipitation (In)	Conditions
7:53 AM	60.1	53.1	78%	30.19	60 / 16	4	1.97 / 0.60	10	SE	8.1	N/A	Mostly Cloudy
8:53 AM	62.1	55	78%	30.18	60 / 16	5	2.30 / 0.70	10	SE	5.8	N/A	Clear
9:53 AM	63	55.9	78%	30.17	60 / 16	5	2.30 / 0.70	10	SE	8.1	N/A	Clear
10:53 AM	63.0	55.9	78%	30.15	61 / 16	5	1.97 / 0.60	10	SE	6.9	N/A	Mostly Cloudy
11:53 AM	64.0	57	78%	30.12	61 / 16	4	1.97 / 0.60	10	Variable	4.6	N/A	Partly Cloudy
12:53 PM	64.9	57	75%	30.09	61 / 16	4	1.64 / 0.50	10	South	6.9	N/A	Partly Cloudy
1:53 PM	64.0	57.9	80%	30.06	61 / 16	5	1.64 / 0.50	10	SSE	8.1	N/A	Mostly Cloudy
2:53 PM	64	59	84%	30.03	61 / 16	3	1.64 / 0.50	10	South	8.1	N/A	Partly Cloudy
3:53 PM	63.0	61	93%	30.02	61 / 16	3	1.97 / 0.60	10	South	6.9	N/A	Clear

Table H- 5. Environmental conditions for 06 November 2004.

Time (EDT)	Temperature (°F)	Dew Point (°F)	Humidity (%)	Pressure (In)	Visibility (Miles)	Wind Direction	Wind Speed (MPH)	Gust Speed (MPH)	Precipitation (In)	Events	Conditions
12:53 AM	37.9	34	86	30.01	10	SW	4.6	-	N/A		Clear
1:53 AM	37	33.1	86	30.01	10	West	3.5	-	N/A		Clear
2:53 AM	35.1	33.1	92	30.01	10	West	4.6	-	N/A		Clear
3:53 AM	35.1	34	96	30.02	10	WSW	3.5	-	N/A		Clear
4:53 AM	33.1	33.1	100	30.01	10	Calm	Calm	-	N/A		Clear
5:53 AM	33.1	32	96	30.02	10	West	3.5	-	N/A		Clear
6:53 AM	32	32	100	30.03	10	WSW	4.6	-	N/A		Clear
7:53 AM	45	37.9	76	30.05	10	WSW	8.1	-	N/A		Clear
8:53 AM	51.1	37.9	61	30.05	10	WSW	8.1	-	N/A		Clear
9:53 AM	55.9	35.1	45	30.02	10	SW	6.9	-	N/A		Clear
10:53 AM	57.9	37	46	30.01	10	SW	11.5	-	N/A		Clear
11:53 AM	57.9	39.9	51	29.96	10	SSW	12.7	-	N/A		Clear
12:53 PM	60.1	39.9	47	29.94	10	SW	12.7	-	N/A		Clear
1:53 PM	60.1	30.9	33	29.91	10	SW	15	25.3	N/A		Clear
2:53 PM	59	30.9	35	29.9	10	SW	18.4	25.3	N/A		Clear
3:53 PM	57.9	34	41	29.89	10	WSW	13.8	-	N/A		Clear
4:53 PM	54	36	51	29.9	10	WSW	9.2	-	N/A		Clear

Table H- 5. Environmental conditions for 06 November 2004. (Cont'd)

Time (EDT)	Temperature (°F)	Dew Point (°F)	Humidity (%)	Pressure (In)	Visibility (Miles)	Wind Direction	Wind Speed (MPH)	Gust Speed (MPH)	Precipitation (In)	Events	Conditions
5:53 PM	52	37.9	59	29.92	10	WSW	8.1	-	N/A		Clear
6:53 PM	50	39.9	68	29.93	10	WSW	6.9	-	N/A		Clear
7:53 PM	51.1	39.9	66	29.94	10	SW	9.2	-	N/A		Clear
8:53 PM	53.1	41	64	29.94	10	WSW	11.5	-	N/A		Clear
9:53 PM	51.1	42.1	71	29.94	10	WSW	9.2	-	N/A		Clear
10:53 PM	52	39.9	63	29.93	10	WSW	9.2	-	N/A		Clear
11:53 PM	53.1	41	64	29.92	10	WSW	10.4	-	N/A		Clear

Table H- 6. Environmental conditions for 07 November 2004.

Time (EDT)	Temperature (°F)	Dew Point (°F)	Humidity (%)	Pressure (In)	Visibility (Miles)	Wind Direction	Wind Speed (MPH)	Gust Speed (MPH)	Precipitation (In)	Events	Conditions
12:53 AM	54	39.9	59	29.92	10	West	10.4	-	N/A		Clear
1:53 AM	53.1	42.1	66	29.91	10	WNW	8.1	-	N/A		Clear
2:53 AM	50	41	71	29.91	10	West	5.8	-	N/A		Clear
3:53 AM	48	43	83	29.92	10	West	6.9	-	N/A		Clear
4:53 AM	42.1	41	96	29.93	10	SSW	4.6	-	N/A		Clear
5:53 AM	39.9	39	97	29.93	10	Calm	Calm	-	N/A		Clear
6:53 AM	45	44.1	97	29.95	10	SW	6.9	-	N/A		Clear
7:53 AM	51.1	46.9	86	29.97	10	SW	4.6	-	N/A		Clear
8:53 AM	57.9	46.9	67	29.97	10	SW	5.8	-	N/A		Clear
9:53 AM	60.1	50	69	29.97	10	SSW	5.8	-	N/A		Clear
10:53 AM	61	46.9	60	29.96	10	South	8.1	-	N/A		Clear
11:53 AM	61	48.9	64	29.92	10	South	8.1	-	N/A		Clear
12:53 PM	61	51.1	70	29.9	10	South	9.2	-	N/A		Clear
1:53 PM	62.1	51.1	67	29.88	10	SSW	11.5	-	N/A		Clear
2:53 PM	62.1	48.9	62	29.87	10	SSW	15	-	N/A		Clear

Table H- 7. Environmental conditions for 27 April 2005.

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
00:50	53 / 12	51 / 10	79%	South	11.7	13.4 / 21.6	4	2.95 / 0.90	exactly 3.0 / exactly 0.9	4	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	7	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.86 / 1011	-0.03 / -1.1
01:50	53 / 12	50 / 10	83%	SE	13.6	15.7 / 25.2	4	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	7	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.81 / 1009	-0.06 / -2.1
02:50	53 / 12	50 / 10	95%	SE	15.6	17.9 / 28.8	5	3.28 / 1.00	exactly 3.3 / exactly 1.0	5	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	7	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.75 / 1008	-0.09 / -3.1
03:50	53 / 12	50 / 10	97%	SE	13.6	15.7 / 25.2	4	3.61 / 1.10	exactly 3.6 / exactly 1.1	4	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	7	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.73 / 1007	-0.12 / -4.1
04:50	55 / 13	50 / 10	93%	SSE	9.7	11.2 / 18.0	5	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	5	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.73 / 1007	-0.08 / -2.6
05:50	53 / 12	50 / 10	96%	SSW	9.7	11.2 / 18.0	4	2.95 / 0.90	exactly 3.0 / exactly 0.9	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.72 / 1006	-0.04 / -1.2
06:50	52 / 11	50 / 10	93%	SW	9.7	11.2 / 18.0	5	2.62 / 0.80	exactly 2.6 / exactly 0.8	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	5	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.73 / 1007	-

Table H-7. Environmental conditions for 27 April 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
07:50	51 / 11	50 / 10	96%	SSW	7.8	8.9 / 14.4	5	2.95 / 0.90	exactly 3.0 / exactly 0.9	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	5	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	29.73 / 1007	-
08:50	51 / 11	51 / 10	97%	SW	5.8	6.7 / 10.8	7	2.95 / 0.90	exactly 3.0 / exactly 0.9	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	7	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	29.73 / 1007	+0.01 / +0.3
09:50	51 / 10	51 / 10	96%	South	7.8	8.9 / 14.4	6	2.95 / 0.90	exactly 3.0 / exactly 0.9	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	6	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	29.72 / 1006	-
10:50	51 / 10	51 / 10	96%	South	7.8	8.9 / 14.4	7	2.62 / 0.80	exactly 2.6 / exactly 0.8	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	7	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	29.72 / 1006	-0.01 / -0.4
11:50	51 / 11	51 / 11	97%	SSW	7.8	8.9 / 14.4	7	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	7	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	29.70 / 1006	-0.02 / -0.8
12:50	52 / 11	51 / 11	97%	SSW	9.7	11.2 / 18.0	9	4.92 / 1.50	exactly 4.9 / exactly 1.5	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	29.70 / 1006	-0.03 / -0.9
13:50	53 / 12	52 / 11	96%	SSW	9.7	11.2 / 18.0	9	5.25 / 1.60	exactly 5.2 / exactly 1.6	5	1.64 / 0.50	0.82 – 2.46 / 0.25 - 0.75	9	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	29.69 / 1005	-0.03 / -1.1
14:50	54 / 12	51 / 11	98%	SSW	13.6	15.7 / 25.2	9	5.25 / 1.60	exactly 5.2 / exactly 1.6	7	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	9	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	29.69 / 1005	-0.02 / -0.6

Table H-7. Environmental conditions for 27 April 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
15:50	53 / 12	51 / 11	99%	SW	11.7	13.4 / 21.6	10	5.25 / 1.60	exactly 5.2 / exactly 1.6	5	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	10	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	29.67 / 1004	-0.03 / -1.0
16:50	55 / 13	51 / 11	90%	SW	9.7	11.2 / 18.0	9	5.58 / 1.70	exactly 5.6 / exactly 1.7	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	29.65 / 1004	-0.04 / -1.3
17:50	54 / 12	51 / 10	95%	SSW	9.7	11.2 / 18.0	8	5.58 / 1.70	exactly 5.6 / exactly 1.7	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	29.67 / 1004	-0.02 / -0.7
18:50	56 / 13	51 / 10	83%	West	25.3	29.1 / 46.8	9	5.25 / 1.60	exactly 5.2 / exactly 1.6	6	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	9	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	29.68 / 1005	+0.01 / +0.4
19:50	54 / 12	51 / 10	86%	North	1.9	2.2 / 3.6	8	4.92 / 1.50	exactly 4.9 / exactly 1.5	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	29.72 / 1006	+0.07 / +2.4
20:50	56 / 13	51 / 10	72%	North	3.9	4.5 / 7.2	8	4.59 / 1.40	exactly 4.6 / exactly 1.4	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	29.72 / 1006	+0.06 / +1.9
21:50	56 / 13	51 / 10	61%	West	5.8	6.7 / 10.8	8	5.25 / 1.60	exactly 5.2 / exactly 1.6	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	29.75 / 1007	+0.07 / +2.3

Table H-7. Environmental conditions for 27 April 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
22:50	53 / 12	51 / 10	-	West	7.8	8.9 / 14.4	8	4.59 / 1.40	exactly 4.6 / exactly 1.4	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	29.75 / 1007	+0.03 / +1.1
23:50	54 / 12	51 / 10	69%	WNW	7.8	8.9 / 14.4	8	4.59 / 1.40	exactly 4.6 / exactly 1.4	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	29.77 / 1008	+0.04 / +1.5

Table H- 8. Weather/wave buoy data for for April 28, 2005.

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
00:50	54 / 12	51 / 10	68%	WNW	7.8	8.9 / 14.4	8	4.27 / 1.30	exactly 4.3 / exactly 1.3	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	29.78 / 1008	+0.04 / +1.2
01:50	54 / 12	51 / 10	62%	WNW	11.7	13.4 / 21.6	8	4.27 / 1.30	exactly 4.3 / exactly 1.3	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.80 / 1009	+0.04 / +1.5
02:50	54 / 12	50 / 10	60%	WNW	17.5	20.1 / 32.4	8	3.94 / 1.20	exactly 3.9 / exactly 1.2	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.81 / 1009	+0.04 / +1.5
03:50	53 / 12	50 / 10	62%	WNW	17.5	20.1 / 32.4	9	4.27 / 1.30	exactly 4.3 / exactly 1.3	3	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	9	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.84 / 1010	+0.06 / +2.0
04:50	53 / 12	50 / 10	62%	NW	15.6	17.9 / 28.8	8	4.27 / 1.30	exactly 4.3 / exactly 1.3	4	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.86 / 1011	+0.06 / +2.2
05:50	52 / 11	50 / 10	64%	WNW	17.5	20.1 / 32.4	8	3.94 / 1.20	exactly 3.9 / exactly 1.2	4	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.87 / 1012	+0.06 / +2.1
06:50	52 / 11	50 / 10	62%	WNW	17.5	20.1 / 32.4	8	3.94 / 1.20	exactly 3.9 / exactly 1.2	4	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.90 / 1012	+0.06 / +1.9

Table H-8. Weather/wave buoy data for for April 28, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
07:50	52 / 11	51 / 10	58%	WNW	19.4	22.4 / 36.0	4	3.94 / 1.20	exactly 3.9 / exactly 1.2	4	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.92 / 1013	+0.06 / +1.9
08:50	51 / 11	51 / 10	63%	WNW	17.5	20.1 / 32.4	4	3.94 / 1.20	exactly 3.9 / exactly 1.2	4	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.94 / 1014	+0.06 / +2.1
09:50	52 / 11	51 / 10	62%	WNW	13.6	15.7 / 25.2	8	3.61 / 1.10	exactly 3.6 / exactly 1.1	4	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.94 / 1014	+0.05 / +1.6
10:50	52 / 11	51 / 11	64%	NW	9.7	11.2 / 18.0	4	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.95 / 1014	+0.03 / +1.1
11:50	53 / 12	51 / 11	61%	WNW	5.8	6.7 / 10.8	7	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	7	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.94 / 1014	-
12:50	53 / 12	52 / 11	59%	WSW	1.9	2.2 / 3.6	9	2.95 / 0.90	exactly 3.0 / exactly 0.9	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.91 / 1013	-0.03 / -1.0
13:50	54 / 12	53 / 12	61%	SSW	3.9	4.5 / 7.2	9	3.28 / 1.00	exactly 3.3 / exactly 1.0	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.92 / 1013	-0.03 / -1.0
14:50	54 / 12	53 / 12	66%	South	5.8	6.7 / 10.8	8	2.95 / 0.90	exactly 3.0 / exactly 0.9	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.94 / 1014	-

Table H-8. Weather/wave buoy data for for April 28, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
15:50	55 / 13	53 / 12	62%	South	3.9	4.5 / 7.2	9	2.62 / 0.80	exactly 2.6 / exactly 0.8	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	29.92 / 1013	-
16:50	57 / 14	53 / 12	49%	WSW	9.7	11.2 / 18.0	8	2.62 / 0.80	exactly 2.6 / exactly 0.8	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	29.91 / 1013	-0.01 / -0.3
17:50	56 / 13	53 / 12	59%	SW	7.8	8.9 / 14.4	9	2.95 / 0.90	exactly 3.0 / exactly 0.9	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	29.92 / 1013	-0.02 / -0.6
18:50	56 / 14	53 / 12	55%	WSW	9.7	11.2 / 18.0	8	2.62 / 0.80	exactly 2.6 / exactly 0.8	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	29.92 / 1013	-
19:50	55 / 13	53 / 12	63%	SW	15.6	17.9 / 28.8	8	2.95 / 0.90	exactly 3.0 / exactly 0.9	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	29.93 / 1014	+0.02 / +0.7
20:50	54 / 12	52 / 11	67%	SW	13.6	15.7 / 25.2	9	2.95 / 0.90	exactly 3.0 / exactly 0.9	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	29.95 / 1014	+0.03 / +1.1
21:50	58 / 14	52 / 11	42%	West	3.9	4.5 / 7.2	8	2.95 / 0.90	exactly 3.0 / exactly 0.9	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.01 / 1016	+0.09 / +3.2

Table H-8. Weather/wave buoy data for for April 28, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
22:50	55 / 13	52 / 11	-	SW	5.8	6.7 / 10.8	8	2.95 / 0.90	exactly 3.0 / exactly 0.9	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.02 / 1016	+0.09 / +3.0
23:50	53 / 12	52 / 11	-	SSE	1.9	2.2 / 3.6	9	2.30 / 0.70	exactly 2.3 / exactly 0.7	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.02 / 1017	+0.07 / +2.4

Table H- 9. Weather/wave buoy data for April 29, 2005.

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
00:50	53 / 12	52 / 11	-	SSE	3.9	4.5 / 7.2	9	2.30 / 0.70	exactly 2.3 / exactly 0.7	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.02 / 1016	-
01:50	53 / 12	52 / 11	-	SSW	5.8	6.7 / 10.8	9	1.97 / 0.60	exactly 2.0 / exactly 0.6	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.03 / 1017	-
02:50	52 / 11	52 / 11	-	SE	1.9	2.2 / 3.6	9	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.01 / 1016	-0.02 / -0.6
03:50	52 / 11	52 / 11	-	ESE	3.9	4.5 / 7.2	9	2.30 / 0.70	exactly 2.3 / exactly 0.7	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.00 / 1016	-0.02 / -0.6
04:50	52 / 11	52 / 11	-	ESE	5.8	6.7 / 10.8	8	1.97 / 0.60	exactly 2.0 / exactly 0.6	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.00 / 1016	-0.02 / -0.8
05:50	52 / 11	52 / 11	-	ESE	5.8	6.7 / 10.8	9	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.00 / 1016	-
06:50	53 / 12	52 / 11	-	East	5.8	6.7 / 10.8	9	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.01 / 1016	-

Table H-1. Weather/wave buoy data for April 29, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
07:50	53 / 11	52 / 11	-	East	7.8	8.9 / 14.4	8	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.03 / 1017	+0.02 / +0.8
08:50	52 / 11	52 / 11	79%	East	9.7	11.2 / 18.0	8	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.03 / 1017	+0.03 / +0.9
09:50	52 / 11	52 / 11	77%	East	9.7	11.2 / 18.0	8	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.02 / 1016	+0.01 / +0.5
10:50	52 / 11	52 / 11	81%	East	9.7	11.2 / 18.0	8	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.02 / 1016	-
11:50	52 / 11	52 / 11	83%	East	9.7	11.2 / 18.0	4	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.01 / 1016	-0.01 / -0.4
12:50	51 / 11	52 / 11	87%	East	9.7	11.2 / 18.0	7	1.97 / 0.60	exactly 2.0 / exactly 0.6	5	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	7	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.99 / 1016	-0.03 / -0.9
13:50	51 / 11	52 / 11	92%	ESE	9.7	11.2 / 18.0	9	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.99 / 1015	-0.03 / -1.1
14:50	52 / 11	52 / 11	92%	SSE	7.8	8.9 / 14.4	8	2.30 / 0.70	exactly 2.3 / exactly 0.7	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.99 / 1016	-0.02 / -0.8

Table H-2. Weather/wave buoy data for April 29, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
15:50	52 / 11	52 / 11	97%	South	7.8	8.9 / 14.4	9	2.30 / 0.70	exactly 2.3 / exactly 0.7	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.96 / 1015	-0.03 / -1.0
16:50	53 / 12	52 / 11	92%	SSW	7.8	8.9 / 14.4	8	2.30 / 0.70	exactly 2.3 / exactly 0.7	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.96 / 1014	-0.03 / -1.0
17:50	53 / 12	52 / 11	93%	SSW	11.7	13.4 / 21.6	9	1.97 / 0.60	exactly 2.0 / exactly 0.6	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.97 / 1015	-0.02 / -0.8
18:50	53 / 12	52 / 11	95%	SW	11.7	13.4 / 21.6	8	2.30 / 0.70	exactly 2.3 / exactly 0.7	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.97 / 1015	+0.01 / +0.3
19:50	53 / 12	52 / 11	95%	SSW	13.6	15.7 / 25.2	9	2.62 / 0.80	exactly 2.6 / exactly 0.8	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.98 / 1015	+0.02 / +0.8
20:50	53 / 12	52 / 11	94%	SSW	11.7	13.4 / 21.6	9	2.62 / 0.80	exactly 2.6 / exactly 0.8	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.00 / 1016	+0.03 / +1.1
21:50	53 / 12	52 / 11	94%	SSW	7.8	8.9 / 14.4	9	2.62 / 0.80	exactly 2.6 / exactly 0.8	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.01 / 1016	+0.04 / +1.2

Table H-3. Weather/wave buoy data for April 29, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
22:50	53 / 11	51 / 11	92%	South	7.8	8.9 / 14.4	8	2.30 / 0.70	exactly 2.3 / exactly 0.7	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.01 / 1016	+0.03 / +0.9
23:50	53 / 12	51 / 11	92%	South	5.8	6.7 / 10.8	9	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.99 / 1016	-

Table H- 10. Weather/wave buoy data for May 4, 2005.

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
00:50	51 / 11	51 / 11	75%	South	5.8	6.7 / 10.8	7	2.30 / 0.70	exactly 2.3 / exactly 0.7	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	7	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.22 / 1023	+0.02 / +0.6
01:50	51 / 10	51 / 11	78%	South	5.8	6.7 / 10.8	11	2.30 / 0.70	exactly 2.3 / exactly 0.7	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	11	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.22 / 1023	+0.01 / +0.4
02:50	51 / 10	51 / 11	80%	SSW	5.8	6.7 / 10.8	7	2.30 / 0.70	exactly 2.3 / exactly 0.7	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	7	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.23 / 1024	+0.01 / +0.4
03:50	51 / 10	51 / 11	77%	SSW	3.9	4.5 / 7.2	13	1.97 / 0.60	exactly 2.0 / exactly 0.6	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	13	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.24 / 1024	+0.02 / +0.6
04:50	51 / 10	51 / 11	80%	WSW	5.8	6.7 / 10.8	13	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	13	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.25 / 1024	+0.03 / +0.9
05:50	51 / 10	51 / 11	80%	West	5.8	6.7 / 10.8	8	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.26 / 1025	+0.04 / +1.2
06:50	51 / 10	51 / 11	84%	WSW	1.9	2.2 / 3.6	12	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	12	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.28 / 1025	+0.05 / +1.6

Table H-10. Weather/wave buoy data for May 4, 2005. (Cont'd)

Update Time	**Temperature**		**Humidity**	**Wind**			**Dominant Wave**			**Wind Wave**			**Wave Swell**			**Pressure**	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
07:50	51 / 11	51 / 11	85%	WSW	3.9	4.5 / 7.2	13	1.64 / 0.50	exactly 1.6 / exactly 0.5	-	-	-	13	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.30 / 1026	+0.06 / +1.9
08:50	51 / 11	51 / 11	85%	WSW	1.9	2.2 / 3.6	12	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	12	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.32 / 1026	+0.05 / +1.8
09:50	52 / 11	52 / 11	81%	WNW	1.9	2.2 / 3.6	11	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	11	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.33 / 1027	+0.05 / +1.6
10:50	52 / 11	53 / 12	82%	NW	1.9	2.2 / 3.6	12	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	12	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.35 / 1028	+0.05 / +1.6
11:50	52 / 11	53 / 12	83%	North	1.9	2.2 / 3.6	13	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	13	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.36 / 1028	+0.04 / +1.5
12:50	52 / 11	53 / 12	79%	North	3.9	4.5 / 7.2	12	1.64 / 0.50	exactly 1.6 / exactly 0.5	-	-	-	12	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.35 / 1028	+0.02 / +0.7
13:50	52 / 11	53 / 12	78%	NE	1.9	2.2 / 3.6	12	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	12	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.35 / 1028	-
15:50	53 / 11	53 / 12	78%	ESE	1.9	2.2 / 3.6	11	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	11	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.35 / 1028	-

Table H-10. Weather/wave buoy data for May 4, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
16:50	53 / 12	53 / 12	78%	NE	1.9	2.2 / 3.6	13	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	13	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.36 / 1028	-
17:50	53 / 12	53 / 12	69%	North	1.9	2.2 / 3.6	11	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	11	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.38 / 1029	+0.02 / +0.6
18:50	53 / 12	53 / 12	76%	ENE	1.9	2.2 / 3.6	12	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	12	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.38 / 1029	+0.03 / +1.0
19:50	52 / 11	53 / 12	84%	South	1.9	2.2 / 3.6	11	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	11	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.41 / 1030	+0.05 / +1.6
20:50	52 / 11	52 / 11	89%	South	1.9	2.2 / 3.6	12	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	12	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.42 / 1030	+0.04 / +1.3
21:50	51 / 11	52 / 11	93%	South	1.9	2.2 / 3.6	11	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	11	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.44 / 1031	+0.06 / +2.0
22:50	51 / 11	52 / 11	93%	South	1.9	2.2 / 3.6	10	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	10	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.45 / 1031	+0.04 / +1.5
23:50	51 / 11	51 / 11	94%	South	1.9	2.2 / 3.6	11	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	11	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.45 / 1031	+0.03 / +1.1

Table H- 11. Weather/wave buoy data for May 9, 2005.

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
00:50	52 / 11	51 / 11	79%	West	5.8	6.7 / 10.8	8	4.59 / 1.40	exactly 4.6 / exactly 1.4	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	29.99 / 1015	+0.03 / +0.9
02:50	51 / 11	51 / 11	87%	WNW	3.9	4.5 / 7.2	10	4.27 / 1.30	exactly 4.3 / exactly 1.3	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	10	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	29.97 / 1015	-
03:50	51 / 11	51 / 10	87%	NW	3.9	4.5 / 7.2	11	4.27 / 1.30	exactly 4.3 / exactly 1.3	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	11	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	29.97 / 1015	-0.02 / -0.7
04:50	51 / 11	51 / 10	84%	NW	5.8	6.7 / 10.8	11	4.59 / 1.40	exactly 4.6 / exactly 1.4	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	11	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	29.98 / 1015	-
05:50	51 / 11	51 / 10	83%	NW	5.8	6.7 / 10.8	9	4.27 / 1.30	exactly 4.3 / exactly 1.3	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	29.99 / 1015	+0.01 / +0.4
06:50	51 / 11	51 / 10	86%	WNW	5.8	6.7 / 10.8	8	4.27 / 1.30	exactly 4.3 / exactly 1.3	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.01 / 1016	+0.04 / +1.5
07:50	51 / 11	50 / 10	82%	WNW	7.8	8.9 / 14.4	9	4.59 / 1.40	exactly 4.6 / exactly 1.4	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.02 / 1016	+0.04 / +1.4

Table H-11. Weather/wave buoy data for May 9, 2005. (Cont'd)

Update Time	**Temperature**		**Humidity**	**Wind**			**Dominant Wave**			**Wind Wave**			**Wave Swell**			**Pressure**	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
08:50	51 / 11	50 / 10	85%	NW	3.9	4.5 / 7.2	9	4.59 / 1.40	exactly 4.6 / exactly 1.4	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.03 / 1017	+0.04 / +1.5
09:50	51 / 11	51 / 10	87%	North	3.9	4.5 / 7.2	10	4.59 / 1.40	exactly 4.6 / exactly 1.4	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	10	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.04 / 1017	+0.02 / +0.8
10:50	52 / 11	51 / 11	80%	North	3.9	4.5 / 7.2	9	4.27 / 1.30	exactly 4.3 / exactly 1.3	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.03 / 1017	+0.01 / +0.4
11:50	52 / 11	52 / 11	84%	NNE	3.9	4.5 / 7.2	11	4.59 / 1.40	exactly 4.6 / exactly 1.4	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	11	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.04 / 1017	-
12:50	53 / 12	52 / 11	73%	ENE	5.8	6.7 / 10.8	9	4.27 / 1.30	exactly 4.3 / exactly 1.3	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.03 / 1017	-
13:50	52 / 11	51 / 11	76%	East	7.8	8.9 / 14.4	10	4.27 / 1.30	exactly 4.3 / exactly 1.3	-	-	-	10	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.01 / 1016	-0.02 / -0.6
14:50	52 / 11	51 / 11	74%	East	9.7	11.2 / 18.0	11	4.59 / 1.40	exactly 4.6 / exactly 1.4	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	11	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.01 / 1016	-0.02 / -0.7
15:50	52 / 11	51 / 11	76%	East	9.7	11.2 / 18.0	9	4.27 / 1.30	exactly 4.3 / exactly 1.3	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.01 / 1016	-0.02 / -0.6

Table H-11. Weather/wave buoy data for May 9, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
16:50	52 / 11	51 / 11	74%	East	7.8	8.9 / 14.4	9	4.59 / 1.40	exactly 4.6 / exactly 1.4	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	30.03 / 1017	+0.01 / +0.5
17:50	51 / 11	51 / 11	79%	East	9.7	11.2 / 18.0	10	3.94 / 1.20	exactly 3.9 / exactly 1.2	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	10	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.02 / 1016	-
18:50	51 / 10	51 / 11	78%	ESE	5.8	6.7 / 10.8	9	4.27 / 1.30	exactly 4.3 / exactly 1.3	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.03 / 1017	+0.01 / +0.4
19:50	51 / 10	52 / 11	76%	SSE	7.8	8.9 / 14.4	9	4.59 / 1.40	exactly 4.6 / exactly 1.4	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	30.03 / 1017	-
20:50	51 / 10	52 / 11	75%	South	5.8	6.7 / 10.8	8	4.27 / 1.30	exactly 4.3 / exactly 1.3	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	4.92 / 1.50	4.10 - 5.74 / 1.25 - 1.75	30.04 / 1017	+0.02 / +0.8
21:50	51 / 10	52 / 11	76%	South	5.8	6.7 / 10.8	10	3.94 / 1.20	exactly 3.9 / exactly 1.2	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	10	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.05 / 1017	+0.02 / +0.7
22:50	51 / 10	52 / 11	77%	South	5.8	6.7 / 10.8	8	3.61 / 1.10	exactly 3.6 / exactly 1.1	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.05 / 1018	+0.02 / +0.7
23:50	51 / 10	51 / 10	78%	South	3.9	4.5 / 7.2	11	3.61 / 1.10	exactly 3.6 / exactly 1.1	-	-	-	11	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.06 / 1018	+0.01 / +0.5

Table H- 12. Weather/wave buoy data for May 11, 2005.

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
00:50	46 / 8	50 / 10	91%	SSE	11.7	13.4 / 21.6	9	4.59 / 1.40	exactly 4.6 / exactly 1.4	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.06 / 1018	-0.03 / -0.9
01:50	45 / 7	50 / 10	95%	South	11.7	13.4 / 21.6	10	4.27 / 1.30	exactly 4.3 / exactly 1.3	5	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	10	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.04 / 1017	-0.05 / -1.7
02:50	46 / 8	50 / 10	92%	SSW	7.8	8.9 / 14.4	11	4.27 / 1.30	exactly 4.3 / exactly 1.3	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	11	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.04 / 1017	-0.03 / -1.1
03:50	46 / 8	50 / 10	91%	SSW	9.7	11.2 / 18.0	9	4.27 / 1.30	exactly 4.3 / exactly 1.3	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.05 / 1017	-0.01 / -0.3
04:50	46 / 8	50 / 10	92%	SSW	7.8	8.9 / 14.4	10	4.92 / 1.50	exactly 4.9 / exactly 1.5	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	10	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.05 / 1018	+0.01 / +0.4
05:50	46 / 8	50 / 10	95%	SW	7.8	8.9 / 14.4	10	4.59 / 1.40	exactly 4.6 / exactly 1.4	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	10	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.06 / 1018	+0.02 / +0.6
06:50	47 / 8	50 / 10	95%	SW	7.8	8.9 / 14.4	10	4.59 / 1.40	exactly 4.6 / exactly 1.4	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	10	4.92 / 1.50	4.10 – 5.74 / 1.25 – 1.75	30.07 / 1018	+0.02 / +0.8

Table H-12. Weather/wave buoy data for May 11, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
07:50	47 / 8	50 / 10	96%	South	7.8	8.9 / 14.4	10	3.94 / 1.20	exactly 3.9 / exactly 1.2	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	10	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.06 / 1018	+0.01 / +0.3
08:50	47 / 9	50 / 10	97%	South	11.7	13.4 / 21.6	10	4.27 / 1.30	exactly 4.3 / exactly 1.3	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	10	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.05 / 1017	-0.01 / -0.5
09:50	47 / 8	50 / 10	97%	South	11.7	13.4 / 21.6	10	3.94 / 1.20	exactly 3.9 / exactly 1.2	5	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	10	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.05 / 1018	-0.02 / -0.7
10:50	48 / 9	50 / 10	94%	SSW	11.7	13.4 / 21.6	10	3.94 / 1.20	exactly 3.9 / exactly 1.2	5	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	10	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.06 / 1018	-
11:50	48 / 9	51 / 10	97%	SSW	11.7	13.4 / 21.6	9	3.61 / 1.10	exactly 3.6 / exactly 1.1	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.06 / 1018	+0.01 / +0.4
12:50	49 / 10	51 / 10	97%	South	11.7	13.4 / 21.6	10	3.61 / 1.10	exactly 3.6 / exactly 1.1	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	10	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.04 / 1017	-0.01 / -0.4
13:50	50 / 10	51 / 10	95%	South	13.6	15.7 / 25.2	9	3.94 / 1.20	exactly 3.9 / exactly 1.2	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.03 / 1017	-0.03 / -1.1
14:50	51 / 10	51 / 11	94%	South	11.7	13.4 / 21.6	10	3.61 / 1.10	exactly 3.6 / exactly 1.1	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	10	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.01 / 1016	-0.05 / -1.7

Table H-12. Weather/wave buoy data for May 11, 2005. (Cont'd)

Update Time	**Temperature**		**Humidity**	**Wind**			**Dominant Wave**			**Wind Wave**			**Wave Swell**			**Pressure**	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
15:50	52 / 11	51 / 11	92%	South	11.7	13.4 / 21.6	10	3.28 / 1.00	exactly 3.3 / exactly 1.0	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	10	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.99 / 1016	-0.05 / -1.6
16:50	52 / 11	51 / 11	95%	SSW	11.7	13.4 / 21.6	9	3.61 / 1.10	exactly 3.6 / exactly 1.1	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.97 / 1015	-0.05 / -1.8
17:50	53 / 12	51 / 11	91%	SSW	13.6	15.7 / 25.2	8	3.94 / 1.20	exactly 3.9 / exactly 1.2	6	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.96 / 1014	-0.05 / -1.6
18:50	53 / 12	51 / 11	92%	SSW	11.7	13.4 / 21.6	8	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.96 / 1014	-0.04 / -1.2
19:50	53 / 12	51 / 11	92%	SSW	11.7	13.4 / 21.6	8	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.97 / 1015	-
20:50	54 / 12	51 / 11	88%	SSW	13.6	15.7 / 25.2	8	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.96 / 1014	-
21:50	54 / 12	51 / 10	87%	SSW	11.7	13.4 / 21.6	9	3.28 / 1.00	exactly 3.3 / exactly 1.0	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	29.98 / 1015	+0.02 / +0.7
22:50	54 / 12	51 / 10	88%	SSW	13.6	15.7 / 25.2	9	3.28 / 1.00	exactly 3.3 / exactly 1.0	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	9	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.96 / 1014	-

Table H-12. Weather/wave buoy data for May 11, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
23:50	54 / 12	51 / 10	87%	SW	11.7	13.4 / 21.6	8	2.95 / 0.90	exactly 3.0 / exactly 0.9	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	29.96 / 1014	-

Table H- 13. Weather/wave buoy data for May 12, 2005.

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
00:50	55 / 13	52 / 11	83%	SW	11.7	13.4 / 21.6	8	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	29.95 / 1014	-0.03 / -1.0
01:50	55 / 13	-	88%	SW	13.6	15.7 / 25.2		/	/	-	-	-	-	-	-	-	-
02:50	55 / 13	52 / 11	92%	SW	11.7	13.4 / 21.6	9	2.62 / 0.80	exactly 2.6 / exactly 0.8	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	29.94 / 1014	-0.02 / -0.6
03:50	55 / 13	52 / 11	96%	SW	9.7	11.2 / 18.0	9	2.62 / 0.80	exactly 2.6 / exactly 0.8	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	29.94 / 1014	-0.01 / -0.4
04:50	55 / 13	52 / 11	95%	WSW	5.8	6.7 / 10.8	8	2.95 / 0.90	exactly 3.0 / exactly 0.9	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	29.94 / 1014	-
05:50	56 / 13	52 / 11	93%	West	5.8	6.7 / 10.8	8	2.62 / 0.80	exactly 2.6 / exactly 0.8	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	29.96 / 1014	+0.02 / +0.8
06:50	57 / 14	52 / 11	96%	NNW	11.7	13.4 / 21.6	8	2.62 / 0.80	exactly 2.6 / exactly 0.8	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.00 / 1016	+0.06 / +2.2
07:50	58 / 14	52 / 11	94%	NNW	11.7	13.4 / 21.6	9	2.62 / 0.80	exactly 2.6 / exactly 0.8	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.02 / 1016	+0.08 / +2.6

Table H-13. Weather/wave buoy data for May 12, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
08:50	57 / 14	53 / 11	94%	North	5.8	6.7 / 10.8	8	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.03 / 1017	+0.07 / +2.4
09:50	57 / 14	53 / 12	93%	North	5.8	6.7 / 10.8	9	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	9	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.06 / 1018	+0.06 / +1.9
10:50	57 / 14	53 / 12	93%	North	5.8	6.7 / 10.8	8	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.07 / 1018	+0.05 / +1.7
11:50	57 / 14	53 / 12	93%	NNW	5.8	6.7 / 10.8	8	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.10 / 1019	+0.07 / +2.3
12:50	58 / 14	53 / 12	90%	NNW	7.8	8.9 / 14.4	8	1.97 / 0.60	exactly 2.0 / exactly 0.6	-	-	-	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.12 / 1020	+0.06 / +2.2
13:50	57 / 14	53 / 12	88%	NNW	9.7	11.2 / 18.0	8	1.97 / 0.60	exactly 2.0 / exactly 0.6	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.14 / 1020	+0.06 / +2.2
14:50	57 / 14	53 / 12	84%	North	7.8	8.9 / 14.4	8	1.97 / 0.60	exactly 2.0 / exactly 0.6	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.16 / 1021	+0.06 / +2.0
15:50	57 / 14	53 / 12	-	NNE	9.7	11.2 / 18.0	7	1.97 / 0.60	exactly 2.0 / exactly 0.6	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	7	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.17 / 1022	+0.05 / +1.8

Table H-13. Weather/wave buoy data for May 12, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
16:50	55 / 13	52 / 11	74%	NE	9.7	11.2 / 18.0	8	1.97 / 0.60	exactly 2.0 / exactly 0.6	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.17 / 1022	+0.04 / +1.3
17:50	55 / 13	52 / 11	69%	ENE	11.7	13.4 / 21.6	7	2.30 / 0.70	exactly 2.3 / exactly 0.7	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	7	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.18 / 1022	+0.02 / +0.7
18:50	54 / 12	52 / 11	70%	ENE	11.7	13.4 / 21.6	7	2.62 / 0.80	exactly 2.6 / exactly 0.8	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	7	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.19 / 1022	+0.01 / +0.5
19:50	53 / 12	51 / 11	73%	ENE	7.8	8.9 / 14.4	7	2.62 / 0.80	exactly 2.6 / exactly 0.8	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	7	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.22 / 1023	+0.05 / +1.6
20:50	52 / 11	51 / 11	80%	East	7.8	8.9 / 14.4		/	/	-	-	-	-	-	-	30.25 / 1024	+0.06 / +2.2
21:50	51 / 11	51 / 10	87%	East	5.8	6.7 / 10.8	4	2.30 / 0.70	exactly 2.3 / exactly 0.7	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	30.26 / 1025	+0.07 / +2.5

Table H- 14. Weather/wave buoy data for May 13, 2005.

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
00:50	50 / 10	51 / 10	94%	NE	3.9	4.5 / 7.2	8	1.97 / 0.60	exactly 2.0 / exactly 0.6	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.30 / 1026	+0.03 / +1.1
01:50	50 / 10	51 / 10	93%	NE	7.8	8.9 / 14.4	8	1.97 / 0.60	exactly 2.0 / exactly 0.6	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.29 / 1026	+0.02 / +0.7
02:50	50 / 10	51 / 10	90%	NE	7.8	8.9 / 14.4	8	1.97 / 0.60	exactly 2.0 / exactly 0.6	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.29 / 1026	-
03:50	50 / 10	51 / 10	89%	NE	7.8	8.9 / 14.4	5	1.97 / 0.60	exactly 2.0 / exactly 0.6	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	5	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.32 / 1026	+0.02 / +0.7
04:50	50 / 10	51 / 10	88%	NE	5.8	6.7 / 10.8	8	1.97 / 0.60	exactly 2.0 / exactly 0.6	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.33 / 1027	+0.04 / +1.3
05:50	50 / 10	51 / 10	87%	NNE	7.8	8.9 / 14.4	13	1.97 / 0.60	exactly 2.0 / exactly 0.6	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	13	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.36 / 1028	+0.06 / +2.2
06:50	50 / 10	51 / 11	88%	NE	9.7	11.2 / 18.0	8	1.97 / 0.60	exactly 2.0 / exactly 0.6	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.37 / 1028	+0.05 / +1.8

Table H-44. Weather/wave buoy data for May 13, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
07:50	50 / 10	51 / 11	86%	NE	9.7	11.2 / 18.0	8	1.97 / 0.60	exactly 2.0 / exactly 0.6	5	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.37 / 1028	+0.04 / +1.4
08:50	50 / 10	51 / 11	87%	NE	9.7	11.2 / 18.0	8	2.62 / 0.80	exactly 2.6 / exactly 0.8	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	30.38 / 1029	+0.02 / +0.8
09:50	50 / 10	51 / 11	81%	NE	11.7	13.4 / 21.6	8	3.28 / 1.00	exactly 3.3 / exactly 1.0	5	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.39 / 1029	+0.02 / +0.6
10:50	50 / 10	51 / 10	74%	NE	11.7	13.4 / 21.6	8	3.61 / 1.10	exactly 3.6 / exactly 1.1	3	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.39 / 1029	+0.02 / +0.6
11:50	50 / 10	51 / 10	73%	ENE	11.7	13.4 / 21.6	8	3.61 / 1.10	exactly 3.6 / exactly 1.1	5	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.39 / 1029	+0.01 / +0.4
12:50	50 / 10	51 / 10	70%	ENE	11.7	13.4 / 21.6	8	3.61 / 1.10	exactly 3.6 / exactly 1.1	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.38 / 1029	-
13:50	50 / 10	51 / 11	69%	East	11.7	13.4 / 21.6	8	3.61 / 1.10	exactly 3.6 / exactly 1.1	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	8	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.37 / 1028	-0.02 / -0.8
14:50	50 / 10	51 / 11	58%	ESE	9.7	11.2 / 18.0	7	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 – 2.46 / 0.25 – 0.75	7	3.28 / 1.00	2.46 – 4.10 / 0.75 – 1.25	30.35 / 1028	-0.04 / -1.5

Table H-54. Weather/wave buoy data for May 13, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
15:50	50 / 10	51 / 11	63%	SE	7.8	8.9 / 14.4	8	3.61 / 1.10	exactly 3.6 / exactly 1.1	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.33 / 1027	-0.05 / -1.7
16:50	49 / 10	51 / 11	69%	SSE	7.8	8.9 / 14.4	7	3.61 / 1.10	exactly 3.6 / exactly 1.1	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	7	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.32 / 1027	-0.04 / -1.5
17:50	49 / 10	51 / 11	74%	SSE	9.7	11.2 / 18.0	8	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.30 / 1026	-0.05 / -1.7
18:50	50 / 10	51 / 11	72%	SSE	9.7	11.2 / 18.0	7	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	7	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.28 / 1025	-0.06 / -1.9
19:50	50 / 10	51 / 11	76%	South	9.7	11.2 / 18.0	6	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	6	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.27 / 1025	-0.06 / -1.9
20:50	50 / 10	51 / 11	78%	South	7.8	8.9 / 14.4	7	3.61 / 1.10	exactly 3.6 / exactly 1.1	3	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	7	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.26 / 1024	-0.04 / -1.4
21:50	50 / 10	51 / 11	81%	South	9.7	11.2 / 18.0	8	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.25 / 1024	-0.03 / -1.1
22:50	51 / 10	51 / 10	80%	South	7.8	8.9 / 14.4	7	3.28 / 1.00	exactly 3.3 / exactly 1.0	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	7	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.23 / 1024	-0.03 / -1.1

Table H-64. Weather/wave buoy data for May 13, 2005. (Cont'd)

Update Time	Temperature		Humidity	Wind			Dominant Wave			Wind Wave			Wave Swell			Pressure	
	Air(°F / °C)	Water(°F / °C)		Dir	Spd (kts)	Spd (mph / km/h)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Period (sec)	Height (ft / m)	Range (ft / m)	Atmosphere (in / hPa)	Tendency (in / hPa)
23:50	51 / 10	51 / 10	83%	South	7.8	8.9 / 14.4	8	2.95 / 0.90	exactly 3.0 / exactly 0.9	4	1.64 / 0.50	0.82 - 2.46 / 0.25 - 0.75	8	3.28 / 1.00	2.46 - 4.10 / 0.75 - 1.25	30.23 / 1024	-0.03 / -1.0

APPENDIX I COLLECTED DATA

I.1 DETECTION DATA SHEET

(Double click icon to open.)

I.2 DEPLOYMENT/RETRIEVAL DATA AND ENVIRONMENTAL DATA

(Double click icon to open.)

October 28, 2004

(Double click icon to open.)

November 2, 2004

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APPENDIX J SEARCH CREW COMMENTS

The following comments made by the search crews were compiled from both test periods.

- Streamers increased Pd for short range targets, but did not contribute to detection range.
- When looking into the sun almost no detections were made.
- When looking across the sun, color contrast diminished.
- When looking with sun behind the A/C, detections were enhanced.
- S-R streamers were definitely more visible with direct sunlight overhead.
- Higher altitudes may increase streamer detections. The S-R is visible when viewed from a steep angle.
- The streamer was not really visible until right on top of target, and by that time, the target has usually been detected by other factors.
- Searchers were cued by the target, not the streamer. I did not see the streamer until directly abeam the target.
- Lack of sunlight made targets less conspicuous than they would be on a sunny day, however the low sea state partially mitigated this effect. Targets (including pot buoys and navaids) with vertical silhouettes were easy to detect despite poor lighting.
- Poor lighting conditions caused by overcast were the major factor that limited detections.
- Heavy whitecap coverage and harsh sun glare hampered detection.
- My eyes followed the S-R streamer to a raft target located directly off the nose.
- Streamers need to be above the surface.
- The detection window for the P-3 at 500 ft and 200 knots is very short, i.e., less than 5 seconds.
- P-3 crews may be missing a large number of targets that are being directly overflown. PIW, in particular, may be disappearing beneath the nose before they come into visual range. As they pass beneath the A/C, the only chance they have of being detected is if a crewman leans forward into the bubble window and looks straight down.

- Lack of contrast made it difficult to keep eyes focused on the surface. There is a strong tendency to be hypnotized by the nearly featureless ocean surface.

APPENDIX K SYSTAT® LOGIT MULTIVARIATE REGRESSION MODEL

K.1 MODEL DESCRIPTION

Multivariate logistic regression models have proven to be appropriate analysis tools for fitting USCG field test search data where the dependent variable is a discrete response (e.g., detection/no detection). The detection data can be analyzed using commercial logistic regression software. The logistic regression model is useful in quantifying the relationship between independent variables, x_i, and a probability of interest (P_D, in this case, the probability of detecting a target of interest). The independent variables can be continuous (e.g., range, wave height, wind speed) or discrete (e.g., radar reflector present or not present (1 or 0)). The logistic regression model has proven to be an effective means of identifying statistically significant search parameters and of quantifying their influence on the target detection probability versus lateral range relationship (i.e., LRCs).

The equation for target detection probability used in the logistic regression model is:

$$P_D = 1/(1+e^{-\lambda})$$

where:

P_D	=	target detection probability for a given searcher - target encounter,
λ	=	$a_0 + a_1 x_1 + a_2 x_2 + a_3 x_3 + ... + a_n x_n$,
a_i	=	fitting coefficients (determined by computer program), and
x_i	=	independent variable values.

The maximum log-likelihood method is employed in the logistic regression statistical software to optimize values of the coefficients a_i. The independent variables (model inputs) can be discrete or continuous types. The statistical significance of these independent (explanatory) variables as predictors of the response are evaluated using the t-statistic outputs of the regression package.

The logistic regression model is used interactively to arrive at a fitting function that contained only those search parameters found to exert a statistically significant influence on the target detection response. These fitting functions were solved to generate LRCs.

A logistic regression model has the following advantages over other regression models and statistical methods.

1. It implicitly contains the constraint that $0 \le P_D \le 1.0$; a linear model does not contain this constraint, unless it is specifically added, and thus significantly increases the computational load.
2. It is analogous to normal-theory linear models; therefore, analysis of variance and regression implications can be drawn from the model.
3. It can be used to observe the effects of several independent or interactive parameters that are continuous or discrete.
4. A regression technique is better than non-parametric hypothesis testing, which does not yield quantitative relationships between the probability in question and the values of independent variables.

One limitation of a basic logistic regression model is that the calculation produces a monotonically decreasing function of the dependent variable (P_D) from the independent variables.

K.2 SYSTAT SR INPUT FILE

S-R Systat Input

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K.3 SYSTAT SR OUTPUT

Final SR-Streamer Model

SYSTAT Rectangular file: S_R_Data.syd,
created Fri Oct 14, 2005 at 14:07:12, contains variables:

SORT	TGT_1RAFTWI	ISRAFTANY	HASSTREAMER	TARGETDETEC	CPARANGE
ALTFT	SLANTLR	OVERCAST	VISNM	TIMEONTASK	POSITION0N
SAWFIRST0N	BESTWSKNOTS	BESTHS	BESTWC	IVIS	HSSQUARED
LIGHTSKY	ISPIW	SLRP15	SLRP1	SLRP2	SLRP175
RAFT_SR	RAFT_NOSR				

```
Categorical values encountered during processing are:
TARGETDETEC (2 levels)
          0,        1

Binary LOGIT Analysis.

Dependent variable: TARGETDETEC
Input records:          838
Records for analysis:          838
Sample split

Category choices
```

```
   0   (REFERENCE)       752
   1   (RESPONSE)         86
Total      :             838

L-L at iteration 1 is     -580.857
L-L at iteration 2 is     -259.494
L-L at iteration 3 is     -214.481
L-L at iteration 4 is     -196.555
L-L at iteration 5 is     -187.808
L-L at iteration 6 is     -183.280
L-L at iteration 7 is     -182.043
L-L at iteration 8 is     -181.975
L-L at iteration 9 is     -181.975
L-L at iteration 10 is     -181.975
Log Likelihood:     -181.975
    Parameter                Estimate          S.E.       t-ratio       p-value
  1 CONSTANT                    3.463         0.745         4.650         0.000
  2 ISRAFTANY*SLANTLR          -3.914         0.509        -7.684         0.000
  3 ISPIW*SLRP175             -13.882         2.385        -5.821         0.000
  4 HSSQUARED                  -0.117         0.038        -3.074         0.002
  5 BESTWSKNOTS                -0.089         0.040        -2.218         0.027
  6 IVIS                      -10.315         3.674        -2.807         0.005
                                                  95.0 % bounds
    Parameter              Odds Ratio         Upper         Lower
  2 ISRAFTANY*SLANTLR           0.020         0.054         0.007
  3 ISPIW*SLRP175               0.000         0.000         0.000
  4 HSSQUARED                   0.889         0.958         0.825
  5 BESTWSKNOTS                 0.915         0.990         0.845
  6 IVIS                        0.000         0.044         0.000
Log Likelihood of constants only model = LL(0) =     -277.222
2*[LL(N)-LL(0)] =      190.493 with 5 df Chi-sq p-value = 0.000
McFadden's Rho-Squared =        0.344
```

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APPENDIX L DATA ANALYSES WORKBOOKS

L.1 SWEEP WIDTH WORKBOOKS

Detection
Spreadsheet

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LRC.XLS

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L.2 CUMULATIVE DETECTION PROBABILITY

CDP.XLS

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APPENDIX M PROPOSED UPDATES TO THE COAST GUARD ADDENDUM TO THE NATIONAL SAR SUPPLEMENT AND THE NAVY SAR PLANNING DOCTRINE NWP 3-50.1 REV. A

Tables H-11 and H-12 in the Addendum to the National SAR Supplement show the following uncorrected visual sweep width (W) data for fixed-wing aircraft as a function of altitude and visibility.

Search Object	*Altitude 300 Feet Visibility (nmi)*							*Altitude 500 Feet Visibility (nmi)*						
	1	*3*	*5*	*10*	*15*	*20*	*30*	*1*	*3*	*5*	*10*	*15*	*20*	*30*
Person in Water w/o PFD	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Raft 1 person	0.3	0.7	0.9	1.2	1.3	1.3	1.3	0.3	0.7	0.9	1.2	1.4	1.4	1.4

Search Object	*Altitude 750 Feet Visibility (nmi)*							*Altitude 1000 Feet Visibility (nmi)*						
	1	*3*	*5*	*10*	*15*	*20*	*30*	*1*	*3*	*5*	*10*	*15*	*20*	*30*
Person in Water w/o PFD	0.1*	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Raft 1 person	0.3	0.7	0.9	1.2	1.4	1.4	1.4	0.3	0.7	0.9	1.2	1.4	1.4	1.4

* This value is a known typographical error that will be corrected to 0.0 in future revisions

The LRC for PIWs with S-R streamer modeled from this field test was compared with the modeled LRC for PIWs without S-R streamer under similar search conditions. The Ws differed by a factor of about 2 with the PIW with S-R streamer being the larger. The shape of the LRCs differed considerably, probably due to different search aircraft designs. For this reason, an addition is recommended to the uncorrected visual sweep width data for the PIW search object wearing a PFD and employing an S-R streamer.

The following additions to the SAR Manual PIW Uncorrected Sweep Width tables are recommended based on the S-R Streamer – P3 Test

Search Object	*Altitude 300 Feet Visibility (nmi)*							*Altitude 500 Feet Visibility (nmi)*						
	1	*3**	*5*	*10*	*15*	*20*	*30*	*1*	*3**	*5*	*10*	*15*	*20*	*30*
Person in Water with S-R Streamer and PFD	0.0	0.0	0.2	0.3	0.3	0.3	0.3	0.0	0.0	0.1	0.3	0.3	0.3	0.3

Search Object	*Altitude 750 Feet Visibility (nmi)*							*Altitude 1000 Feet Visibility (nmi)*						
	1	*3**	*5*	*10*	*15*	*20*	*30*	*1*	*3**	*5*	*10*	*15*	*20*	*30*
Person in Water with S-R Streamer and PFD	0.0	0.0	0.1	0.2	0.2	0.2	0.2	0.0	0.0	0.1	0.1	0.1	0.1	0.1

**These recommendations are based specifically on employing a Naval P-3 as an SRU. If SRUs with better forward visibility such as CG HC-130s are employed in search for a PIW with PFD and S-R Streamer, the 3 mile visibility values listed as zero may be raised to 0.1 nmi.*

Prior to the NSMRL S-R project no search performance data had ever been collected with 1 person life rafts. When the LRC model developed from the collected data was run for the tabulated range of altitudes and visibilities, it became evident that the 1-person life raft W values in the current Addendum to the National SAR Supplement are too large. The revised W values tabulated below are recommended for 1-person SEIE life rafts with or without an S-R streamer when aircraft similar to the Navy P-3 are used as the search platform. The LRC model was not run for visibilities greater than 10 nmi because it is not likely that increases in visibility beyond 10 nmi will improve detection of the SEIE rafts. The demonstrated maximum detection range against these search objects was less than 1.8 nmi.

Search Object	*Altitude 300 Feet Visibility (nmi)*							*Altitude 500 Feet Visibility (nmi)*						
	1	*3*	*5*	*10*	*15*	*20*	*30*	*1*	*3*	*5*	*10*	*15*	*20*	*30*
Raft 1 person	0.0	0.1	0.4	0.7	0.7	0.7	0.7	0.0	0.1	0.3	0.7	0.7	0.7	0.7

Search Object	*Altitude 750 Feet Visibility (nmi)*							*Altitude 1000 Feet Visibility (nmi)*						
	1	*3*	*5*	*10*	*15*	*20*	*30*	*1*	*3*	*5*	*10*	*15*	*20*	*30*
Raft 1 person	0.0	0.1	0.3	0.7	0.7	0.7	0.7	0.0	0.1	0.3	0.6	0.6	0.6	0.6